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THE ESSENTIALS OF A COURSE IN ZOOLOGY FOR SECONDARY SCHOOLS.*

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[EDITORIAL NOTE.—This article marks still another step away from the influence of the formal evolutionary biology of the colleges. Are college biologists taking note of this movement? As Prof. Galloway points out, the material of zoölogy affords splendid opportunities for coming into a sympathetic understanding of nature and for stimulating to intellectual activity through problem solving and problem raising.]

This purely personal report on the teaching of zoölogy is intended only as a suggestion in the direction of making concrete some of the fundamentals mentioned in the reports of the last two years. In introducing it I trust you will allow me to repeat my closing remarks in presenting the report of your committee of last year:

"The teacher of biology is an experimental and comparative psychologist. The pupil is the subject of the experiment. The teacher is taking from the wealth of plant and animal phenomena certain materials and is using these to produce certain reactions on the part of the pupil. He is compelled to measure individual progress by the nature of the responses which the pupil makes to the various stimuli which he can bring to bear upon him. Each pupil is a different organism whose reactions must be watched and interpreted. The stimuli must be continually readjusted—not in consonance with a harmony preëstablished by an association of biologists, but in respect to the peculiar response of the pupil whose personality is being developed. The pupil must be kept responsive, and not be allowed to become permanently quiescent in the presence of unsolved questions. It is through some such attitude on the part of the teacher that it may become possible to secure a mental adjustment to discovered facts without losing the attitude of alertness to the unknown, which we have called adjustability."

*A portion of the Report on Fundamentals before the Biology Section of the Central Association of Science and Mathematics Teachers, Chicago, Nov. 26, 1909.

The contribution which this special report hopes to make to the pedagogy of our subject is in the direction of giving a more *immediate motive* to the teacher in respect to the various possible exercises of zoölogy. A motive is valuable in proportion to its vividness and to the constancy with which it can be held before the mind. Its vividness is increased by *nearness* of its realization. It is therefore desirable that the teacher have, in addition to a *general* pedagogical motive for the course as a whole, some more immediate motives in respect to certain parts of the subject and to certain forms of exercise. For this reason he needs to make for himself some analysis of the particular things to be accomplished in and for the youth and of the phases of zoölogical teaching which may meet, more or less well, these needs.

It is hoped that the brief outline presented here falls somewhere between the deadening detailed "outline" of the Huxley type, on the one hand, and the unorganized chaos which is inevitable when only the pupil's interest is consulted in the conduct of the course. It is believed by the writer that the interest of the pupil should figure largely in the beginning, but that it is desirable—and possible, without doing any violence to either quantity or quality of interest—to direct it into such well-thought-out channels as the teacher may deem wise. It is all right to commence *"anywhere"* in our work; but we must get *"somewhere."*

In such a course as is contemplated here the pupil too must have a motive more immediate than that of fitting himself for life. Much emphasis is put, nowadays, on the value of the "problem-solving attitude," and rightly. But the writer feels that we should be wise enough to secure from the pupil—in work so interesting naturally as our own—something more vital still:—to wit—the *problem raising* attitude. As far as may be the teacher should in these various types of exercise get the pupils themselves to raise the problems—and hence help develop their own outlines—under guidance of course. Nothing else will give such motive to the pupil nor such initiative in problem solving.

The estimate of time is merely suggestive throughout. The first figures are based on one half year, and the second on a whole year of work given to the subject.

In what follows it is assumed that the course in zoölogy ex-

tends through a whole year,—about the *second* of the high school; that two periods a week, on an average, will be given to text-book and lectures; and that three or four periods a week will be given to "practical" work. By practical work is meant field work, laboratory work, and reference or research work in the library on special topics.

A. General Division of the Year.

The months of September, October and November should be given, as largely as possible, to the study and discussion of the field and the natural relations of the animals to their whole environment. The winter months—December to March inclusive—should be given largely to the laboratory, the text, and the library. The remaining months should renew the work in the field in order to give a better idea of seasonal influences, of the annual reproductive cycle, and the general return of the richness of life. Some calendar studies, requiring outdoor observations *throughout the whole year*, should be assigned to each student.

B. A Suggested Order of Exercises.

1. *Introduction to the Field.*

a. A preliminary, unguided excursion, in small groups and in various directions, with instructions to each student to observe, to take notes, and to report on the topography and general natural conditions, and upon all animal life found in these conditions. The excursion should be organized so as to have some members of the party visit all the vacant lots, the gardens, orchards, fields, parks, lakeside, ponds, streams, woods, zoölogical gardens, or whatever else may promise to be fruitful. As much initiative as possible should be allowed to each group of students. This should be followed by detailed discussions in class. If the results desired by the teacher are not well accomplished in the first excursion it should be repeated, changing the direction which each group of students takes.

Objects:—Acquaintance with the local conditions of land and water, and with the elements of the areal distributions of animals; and to raise new questions in the minds of the pupils.

Time:—3 to 5 periods.

b. A general collecting excursion, in groups of three or four, each supplied with suitable receptacles. Each group should be instructed to bring to the laboratory some of the best specimens of animal life which it can find, together with full notes of the

place of finding, and all other facts relating to the life and habits of the forms. Notes should also be made of specimens *observed but not collected*—as of birds, fish, mammals, etc. Follow by a series of full discussions in class. Specimens should be numbered and placed in vivaria, or preserved in suitable way for later study.

Objects:—Closer acquaintance with the distribution of animals; student initiative in making selection of interesting forms for future study; the beginnings of a collection of materials to illustrate to the class the animal life of the community. (Follow by such general or special collecting excursions as may be necessary or possible.)

Time:—3 to 5 periods.

2. *Introduction to the Library and to the Classification of Animals.*

a. By reference to all the books and figures available, allow the students the very natural gratification of locating, as well as they can, the materials they have collected. This is of course merely a preliminary and superficial classification. It is, however, of considerable value, pedagogically.

Objects:—To show how books may be used to bring what other people have done into relation to what the *student is now doing,* with the stress on the latter; to give the student a more definite sense of the scope of the animal kingdom, and of the superficial differences between the important phyla.

Time:—2 to 5 periods.

b. In some periods, when weather conditions are not favorable for outdoor work, have each student handle and make a list of all the books available for reference in the school library—with his own notes as to their scope and value. A carefully prepared, but informal, talk by the teacher on this subject might properly follow this.

3. *Calendar Work.*

The assignment of some particular species, or even larger group, of animals to each student for continued observation, with notes throughout the year; to be followed by a final report to the class at the end. Such studies should include the changes and fate of the individual animal; the varying habits; the principal relation of the individuals to one another and to the environment generally; the times and seasons of the various activities, and the like. Good forms to study are: the various com-

mon species of birds, of insects, spiders, frogs or toads, snakes, the small mammals. A portion of the class might properly study some of the domestic and semi-domestic animals. Study of forms harmful to human interests should be made.

Objects:—To give to the student's interest an extension in time; to introduce accurate study of seasonal and other changes and adjustments,—as migration, moulting, egg-laying, hibernation, and many others; to secure intensive interest and work on one group.

Time:—Throughout the year,—amounting perhaps to 15 to 20 periods.

4. *Continuance of Class Field Work: Introduction to Physiology through Ecology.*

Allow the students to take part in the selection of some type for intensive study in the field by all the members of the class. The form studied will depend on the time of year and the local conditions. Usually the locusts (grass-hoppers) are excellent forms for such work. Any species of insects, or of other animals that are abundant and can be closely approached in the field, will serve. These studies should be careful and extended, and should include:

a. All that can be made out of the following points and such other similar ones as the student and teacher may add: where found; the special surrounding which it prefers; its habits in relation to food, motion and locomotion, mating, reproduction, care of young; defense from enemies or other unfavorable conditions, as cold or drouth; its mode of attacking its prey; etc.

All possible natural powers, activities, modes of sensitiveness, and relations to other animals, of its own or other species, should be worked out by each student. In what various ways do its powers and habits of life adjust it to the conditions in which it lives?

b. The observable external structures by which it is able to do the things which have been discovered. Which of these structures seem strikingly adjusted to the work to be done and to its general habits of life? In what particulars?

c. How does the organization and differentiation of this species compare with that of other animals of your acquaintance?

d. Individual variations. In what particulars?

[Follow by class discussions, so that each student may profit by observations of all.]

Objects:—To give some first-hand and exact knowledge of the relation of some species of animals to its whole environment; to make concrete the idea of adaptation; to introduce that of organization in relation to activities and situations; to suggest variability; to give practice in exactness of observation and expression of results.

Time:—5 to 15 periods.

5. *A Laboratory Supplement to 4* (or if absolutely necessary, a substitute for some of 4). Pursue at still shorter range, and by experimentation, any unsettled questions of general structure, sensitiveness, activity, and the like.

Objects:—To acquaint the student with the necessity of re-testing observations and of correcting them in the interest of exactness; to distinguish between experiment and observation.

Time:—3 to 5 periods.

6. *Introduction to Formal Laboratory Work and to the Scientific Method of Mental Procedure.* (But for the necessity of using the early fall months for outdoor work, this should come earlier). Two sample exercises.

Exercise I—Forms of Matter. Cause each pupil to examine with the utmost care each of the following classes of objects, in order: (1) fine sand, (2) pebbles, (3) crystals of several kinds, (4) shells of various kinds, (5) some typical and accessible plants, and (6) animals.

(1). Observe, and make an exact record of all the actually observed qualities and characteristics of sand grains. Discuss each suggested characteristic and see whether it is observed, or reasoned out from some other observation. Do not allow general inferences to creep in. Would a stranger by reading one of the lists be able to recognize that sand was the object of study? Similarly with each of the other classes of objects.

(2). Compare the various qualities of sand. Are any of these qualities at all related to others? Likewise compare the observed qualities of each of the other types.

(3). Distinguish in each class of objects which are the *essential* and which the *relatively unimportant* qualities among those that have been mentioned. Which of the qualities of sand *make it sand?* So with the others. Check in some way the important qualities.

(4). Compare the six classes of objects on the basis of these recorded characteristics. Does the effort to compare cause you to discover any qualities that you had overlooked?

(5). Classify these six classes by grouping them in respect to the more fundamental likenesses and differences indicated in your lists.

(6). Deduce some general conclusions or statements of truth with respect to the various forms of matter, that seem to be justified by your observations, comparisons, etc.

(7). Make renewed observations of the six types of objects and also of still other forms of matter, such as drops of water, a geode, a watch, starch, infusorial earth; and see whether any of the general conclusions need modification.

Objects:—To allow the pupil to follow his own observations on through to legitimate conclusions; to teach him the principal steps in going from observation to conclusions; to direct his attention to his own personal powers and processes; to give him concrete and first-hand knowledge of the differences between amorphous inorganic matter, crystalline inorganic matter, organized matter that is not alive, and organic matter that is alive.

Time—6 to 12 periods.

Exercise II—Forms of Life.

In a similar way bring to the attention of the pupil such organisms as toad-stools and mushrooms; bread and other molds; bacteria; yeasts; algæ; wheat and corn, or other common green plant; and animals, as the earthworm, frog, cat, man. Handle this material in a manner similar to that in Exercise I, but supplement the pupil's limited observations and experiments with those of the teacher, or others, in respect to the possibility of nourishing these various organisms by means of culture fluids of different kinds.

Organisms may be classed as follows:

A. Those organisms able to subsist upon inorganic food.

B. Those organisms requiring organic food.

Do A and B together include *all* possible organisms? Can an organism belong to both A and B? To which of these groups does each of the types of organisms studied above belong?

Organisms may also be classed as follows:

I. Plants.

II. Animals.

Do these include all organisms? Can an organism belong to both at once? To which does each of those studied above belong? Develop the relation between this classification and the

one given above. Is this equation true: A+B=I+II? Develop how much of A corresponds to I.

Objects:—To continue the observational method, *plus* the use of the observations and experiments of others; to help the student group the organisms of his acquaintance into three groups—animals, fungi, and green plants—with some knowledge of the distinctions between them, in respect to the manner of getting the necessary C and N.

Time:—4 to 8 periods.

7. *The study of a Representative Animal*:—*an Introduction to Morphology through Physiology.*

Probably the best single animal generally available for this purpose is the common crayfish. The honey bee, the grasshopper, the fish, the frog, or any other form large enough and abundant enough may be used; but the crayfish has such a remarkable differentiation of external organs as to be especially favorable.

a. Renew acquaintance with *all observable activities* and powers of the living animal.

b. Find by careful observation and experiment all items of external form and special organs that assist the animal to do these things. Make a complete record (drawings and notes) of all discoverable relations between structure and any of these powers.

c. Extend the same study to the *internal organs,* by dissection. To what of these can you fairly assign (by inference) a function? Enumerate your evidences. By reference determine whether your conclusions agree with those of the authors. Do you find adequate ground to accept their conclusions as to the function of those organs which cannot be observed directly in action?

d. Make a parallel column list of *all observed powers* and the *corresponding organs.* Add next to this list such other powers as you believe the animal to have, but were unable directly to observe, together with their organs.

Objects:—To enable the student to pass naturally from activities to the structures that perform the activity; to give him a sense of the organization and differentiation of a complex animal, and of the division of labor that accompanies it; to enable him to realize that we study the dead body only to give us more light on the nature of the life processes.

Time:—10 to 20 periods.

8. *An Introduction to Economic Zoölogy—(Throughout the course).*

Find out by questioning how much appreciation the student has of the relation of the lower animals to man:—as necessary, useful, indifferent, or harmful. Secure from him a classification of all the kinds of helpfulness or hurtfulness (direct or indirect) known to him. By means of quiz, conference, library reference, etc., extend this knowledge and classification until all the chief relations have been brought to his attention and he knows in what ways the chief animal groups are related to human welfare. The essential facts of animal husbandry and its purposes, of the fisheries, of economic entomology, of household pests and their habits, of human diseases produced or communicated by animals, and other similar great divisions of the subject, should be developed.

Objects:—That the student may see that many animals are important to man; that he may see the fallacy of the idea that *all* animals were made to contribute to man's well-being; that his interest may be aroused in the various instrumentalities for the destruction of the hurtful and the conservation of the helpful animals.

Time:—5 to 10 periods—and all through the course wherever possible.

9. *The Text-Book;—and such Continuance of the Laboratory Work in Physiology and Morphology as Time will Permit.* This is the domain of much of our conventional courses, and needs no comment.

Objects:—To give body and unity and continuity to the practical exercises; to give a rounded and balanced view of the science and of the animal kingdom; to give a more definite conception of the important phyla and of the progressive or evolutionary character of the series.

Time:—40 to 60 periods.

10. *Man's Place in the Animal Series.*—If the text-book does not provide for it, several periods should be given to a candid and careful study of the points at which man is similar to the lower animals, and those at which he differs from them. Some study should be made of the different races of men—their differences and distribution. Some comparison of the life of primitive man with that of our modern civilization should be made. In what does this "progress" from primitive conditions consist?

What are some of the chief physiological abuses that are related to this progress?

Objects:—To make clear that man is of similar nature, and subject to conditions similar to those of other animals; to make clear that we get light on the laws of human behavior by studying zoölogy; to force recognition of the fact that man can no more defy the laws of his nature with impunity than can the lower animals, even though he may postpone the penalty.

Time:—3 to 5 periods.

11. *The Spring Field-work.*

Excursions, observations, experiments, and reports on the renewal of life—supplementing and extending that of the autumn. This period is especially favorable for the study of the return migration of birds; the resumption of activity of the native animals; the nesting, the egg laying and other reproductive processes; the embryonic life of many forms; the metamorphosis of insects; the care of young; the relations of insects to leafing, blooming, and fruiting plants, etc. These problems should be worked out, with some care, for the particular locality, by the teacher, and assigned in an orderly way by him to the members of the class, but with reference to their natural interests.

Object:—To make the pupils naturalists in spirit, whatever is to be the vocation.

Time:—Through the spring months, amounting to 15 to 30 periods.

Statistics showing the output of refined copper by plants in the United States are not now collected by the Geological Survey. Figures published by the Copper Producers' Association indicate that the production of marketable copper from all sources, domestic and foreign, for the first eleven months of 1909 will exceed 1,400,000,000, as against 1,161,176,085 pounds in 1908. Statistics showing domestic deliveries for the first eleven months of the year, as given by the Copper Producers' Association, indicate a consumption of copper in the United States considerably greater than the previous record consumption—682,000,000 pounds, in 1906. Topographic and geologic surveys were made in 1909 in Alaska of areas exceeding 4,000 and 5,000 square miles, respectively. Two of the copper-bearing belts of southeastern Alaska were mapped in detail and the copper and gold-bearing belt extending from the head of Copper River to White River was covered by a reconnaissance survey. Gold deposits, coal beds, and water resources of parts of Alaska were also studied, and statistics were collected to show the mineral production of the Territory.—*U. S. Geol. Survey.*

THE METHODS, CONTENT AND PURPOSE OF BIOLOGIC SCIENCE IN THE SECONDARY SCHOOLS OF THE UNITED STATES.

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*(Continued from January issue.)**

In 139 school courses morphology is given prominence (as may be other aspects of the science); in 178 courses physiology; 76 courses place emphasis on natural history; 27 on taxonomic teaching *per se;* 136 bring out the ecologic aspect; 138 lay emphasis on the relation of biologic science and its data to human welfare, while 55 schools direct the bearing of their courses toward the side of human biology.

It would be impossible in the space devoted to this article to more than hint at the reasons given for the placing of emphasis as shown above. The data, collected from these and other sources will be presented at another time.

In general, however, we find two dominating factors shaping secondary school science courses, one interest and the relation of the science to human welfare, the factor of utility: the other the factor of college entrance requirements, a demand for science courses late in the secondary school, taught so far as is practicable, from the standpoint of the university.

The summary shown above is, on the whole, a commendable rebuke to the university. It shows independence of thought and of aim on the part of the teachers of the secondary schools. It shows a reaction, too, against the college preparatory course planned by college or university men for college preparation only and declares in favor of a rationally planned course or courses, pedagogically planned with reference to the factor of human interest.

In this connection the answers received to the following questions are of considerable interest in the determination of the attitude of the secondary school teacher of biological science toward the college or university, and to a greater degree, the reaction of the student toward the college entrance requirement

*Erratum—Foot-note 2 on page 4 of the January issue refers only to the table on page 3.

in biology, a requirement now long enough in existence to have been given a trial by secondary school and college.

In answer to the question, *"To what extent do your high school students elect biological sciences for college entrance?"* a relatively large number of schools (125 out of 276) do not report. Of the schools reporting 38 send a considerable number of the students *electing* biology to the college entrance examination in this subject. This number varies from 50 per cent in four cases to as low as 10 per cent in others. Sixty-six schools report sending students *very* infrequently to college offering biological science as an entering science, while fifty-three schools send no students to college with biologic science as a college entrance subject. Illinois leads in the number of schools reporting using the college entrance in botany or zoölogy, while Michigan, Ohio, New York, Wisconsin, Indiana, Iowa, and Nebraska follow in the order named. It is needless to add that schools sending pupils to the college entrance examinations offer elective courses relatively late in the school course and in line with the requirements emanating from the colleges which they feed.

On the other hand the answers to the question, *"Are such courses planned to meet the requirements of any college or group of colleges?"* elicited the information that of 186 schools answering this question only 73 did specifically model their courses to conform to the college entrance requirements,[6] the other 113 schools disregarding college entrance requirements *per se*. These requirements are specified by the various state universities fed by the high schools reporting, the examinations set by the boards of the Middle States and Maryland, the North Central Association, the North Western Association, the College Entrance Board and Harvard, Columbia, Leland Stanford, Woman's College (Baltimore), Simmons College (Boston), and various normal and agricultural colleges in various states.

This is preëminently the age of science. The most serious consideration should be given to the preparation in science of the student who never goes beyond the secondary school, for whom the elementary science training there received means equipment for life. In planning a course in biological science

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[6] This is partly in line with Prof. Caldwell's findings:

Do not consider college entrance requirements,	23
Plan course to meet college entrance requirements,	19
Must meet requirements of a state course of study,	3

for such students (and they form by far the major part of every high school) it is necessary to have in mind the utility side of the problem. In order to find out whether this factor was in the minds of the secondary school teacher of biology the following question was proposed: *"Should a course in elementary biology in the high school place more emphasis on training in science method or should the utility value of the science be given first place?"*

	EMPHASIS PLACED ON		
	Utility	Scientific Training	Both
New Hampshire	2		
Massachusetts	16	4	7
Vermont	1		
Rhode Island			2
Connecticut	2	3	2
New England States, Total	21	7	11
New York	14	11	12
New Jersey	2	2	1
Pennsylvania	5	5	1
Maryland	1		
District of Columbia			1
Middle States, Total	22	18	15
Virginia		1	
Kentucky		1	1
Tennessee		1	
Louisiana	1		
Oklahoma			
Southern States, Total	1	3	1
Ohio	11	6	4
Indiana	4	4	4
Illinois	11	7	11
Michigan	3	7	1
Wisconsin	8	2	1
Minnesota	1	2	1
Iowa	2	3	
Missouri	2	3	2
North Central States, Total	42	34	24
North Dakota	1	1	1
Nebraska	1		1
Kansas		1	1
Colorado			2
Utah		1	
Rocky Mountain States, Total	2	3	5
California	3		1
Washington	1	1	
Oregon	1		
Pacific States, Total	5	1	1
GRAND TOTAL	93	66	57

Of the schools answering this question 93 stand for utility value, 66 for science training and 56 place the emphasis equally on both aspects of the subject. The table following is self-explanatory.

A few of the many reasons stated for making the utility value of the science preëminent are given in the following paragraphs. It will be noted that although conditions vary greatly among the various schools from which reports were received, still the underlying thought in the mind of the teacher is to make biologic science an introduction to the world of nature as it touches the life of the pupil. Not to lose sight of accuracy, to impress the importance of the method of science and to make biology utilitarian in its impress on the life of the pupil.

Los Angeles, Cal.: "Scientific method should be emphasized to the extent of insight as to the how and why thus accomplishing in the pupil an *efficiency* so far as the work proceeds; but since 90% of our high school pupils go out into active life with no other training utility should be chiefest aim in the course." Grand Forks, N. D.: "We try to give a knowledge of plant and animal life that will give an interest in one's surroundings. We give first place to utility but we try to leave the student in a position to continue his work in college if he so desires." Streator, Ill.: "By all means give the 'utility value' first place. All modern instruction tends toward 'science method'; in fact laboratory methods have become so prevalent in many departments that pupils are found very deficient in concrete knowledge; there seems to be too much abstraction, too little real scientific classification of what is abstracted and still less memorizing of the conclusion deduced. We need more text-book work, the pendulum has swung too far." Chicago, Ill.: "I believe that the utility value should be given first place because it arouses more interest than any other factor." Elgin, Ill.: "Utility should have first place but the method should always be scientific. Utility need never be sacrificed." This reply is in substance the type of a large number of others, all of which declare that science training may be the means to an end which is a knowledge of science which the pupil may make use of in everyday life. As a teacher from Oak Park, Ill., says: "Emphasis on useful things does not exclude training in the scientific method." Moline, Ill.: "Utility value should be made the basis for selection of the forms studied, and then scientific methods of work should be emphasized in class work." Hammond, Ind.: "Utility value, if in that you include the awakening of interest in outdoor life as it is found in the community." Shreveport, La.: "Utility and interpretation. Science method only to enable pupils to sympathize with and interpret the work of scientists." Gloucester, Mass.: "Utility value by all means; 'science training' smacks too much of the slavery imposed by college preparation." Boston, Mass.: "Attention should be

given to points of economic importance, but the object of the course should be to introduce the pupils to the living world around them in as simple and logical a way as possible so that the pupils may gain in power to interpret what they see, to understand the ways of nature and to appreciate biologic laws." Minneapolis, Minn.: "Utility value, in so far as this means the relating of the pupil to his environment." Baltimore, Md.: "Economic biology should be given an important place in the high school course." St. Louis, Mo.: "Should be approached as far as possible from the side of utility but every part of it should be a training in scientific method." New York City: "It should give the student a general view of the fundamental principles of plant, animal and human functions. Much of accurate training is impossible in the first year." Olean, N. Y.: "Utility value. We are trying to make citizens, not scientists." Cincinnati, O.: "If by 'science method' laboratory technique is meant, then the utility value seems more important, but the habit of clear and scientific *thinking* seems most important of all." Erie, Pa.: "Utility value is certainly very important. I confess that I see no reason why the science method should not be the backbone of such a utility course. The problem is how to combine the two. I am sure that I have sacrificed too much to science method. Elementary biology in a high school should be broad." Superior, Wis.: "The two values cannot be sharply separated; in a general way the utility value should be given first place in a public high school." Seattle, Wash.: "We try to emphasize utility value first and follow with science method. Our object should be to stimulate interest; not prepare for the university at the expense of everything else."

It must not be inferred, from these answers, that the teachers who maintain that science training and the training for the college preparatory student are most important do not make a strong argument. It is the purpose of this article to show that all over the country there is a steadily increasing number of students of educational affairs, who are ready to protest against the present status of all science work in the secondary school and the dominance of the college and university. That biologic science is of the utmost importance all believe, that its power for good might be increased is also evident, if the answers quoted above mean anything.

But if the preparation of the pupil for college is an important function of the secondary school, then much greater is the problem of how best to fit for life the hundreds of thousands of young people who leave our high school doors every June at the end of their first, second, third, or fourth year with the world before them. Our last and most important question deals with this problem: *"How should the course in biologic science adapt itself to the needs of the student who does not go*

to college and for whom the high school is the only preparation for his lifework?"

To attempt to answer this question would be to transcribe a very large number of the answers received. I shall take the space for a few which express in a general way the sentiment of many others.

New Haven, Conn.: "It (biologic science) should teach a student to observe accurately; to record honestly and clearly his observation, to think his own thoughts and not depend upon the ideas of others. 2. It should put the student in an attitude of mind to appreciate the work that is being done in medicine, surgery, preventive medicine, bacteriology, hygiene, and sanitation and in the departments of agriculture, forestry, etc. 3. It should give the student an interest in outdoor life and some resources of interest in the great problems of life that will lift him above mean or selfish trivialities." Oak Park, Ill.: "We do not concern ourselves with the demands of the colleges. Our school is for the pupils and if the colleges do not like the best that can be done for the pupils (a course in elementary science which places emphasis upon the things the students meet in everyday life, a sort of advanced nature study) we let them do the worrying." Paducah, Ky.: "The course should be so conducted that the student will be able to keep up his reading along biological lines and be prepared to understand the advances which are being made in the science; also to be able to discuss and understand the more important principles." Somerville, Mass.: "Course should train in observation, thereby giving meaning to common processes in animal and plant life, and giving knowledge of many facts which an educated person needs in life." Haverhill, Mass.: "The result should enable the young men to become good fathers and members of city councils, understanding the laws of health and sanitation; and the young women good mothers and tidy and *economical* housekeepers." Gloucester, Mass.: "Fundamental facts and data should only be taught with constant eye to the practical." Sault Ste. Marie, Mich.: "Develop right thinking, using material that will be likely to touch the pupil in home, garden, farm or workshop." St. Louis, Mo.: "Granted that the vocation of the average city pupil will not be a biological one, we think it worth while to give him sufficient insight into biology to enable him to understand public questions concerned with biology, to assist him in applying biological laws to his own life and perhaps tempt him to make the woods and fields a sensible recreation." Buffalo, N. Y.: "I believe all problems of public health should be given ample time to discussion. That fear of animals should be removed through familiarity, methods of control and extermination for pests should be taught, love for birds stimulated, etc." Massillon, O.: "I believe we owe more to the student who must begin lifework than to the 'college' student. Also that college demands should be such that we may train for life and not 'train for college'—then let the college take our students where we must leave them and continue college work." Newport, R. I.: "Biology should be practical even at the expense

of technicalities." Erie, Pa.: "The course must be broader, at least in view of the present requirements of the colleges. There ought to be a way of correlating the various branches of the subject so that a high school course in biology would give the college student the right *principles* on which to proceed and at the same time would give him training and information which would enable him to prepare for life without going to college. I think the colleges do not appreciate the value of that kind of training. It should be recognized." Reading, Pa.: "I believe it should adapt itself so that the student becomes familiar with his *everyday environment* and learn to appreciate its influence upon his own well-being. To that end laboratory technique, microscopic examination, and study of rare forms, discussion of biological theories, etc., should be reduced to a minimum." Superior, Wis.: "The high school course should be given for the student who does not go to college. The purpose of the course is to enable the student to get some understanding of life and life's problems."[7]

What has been written above by the last writer will apply equally well as a statement regarding all of our secondary school studies. For sooner or later the educated public must see that the educational authorities are misdirecting the efforts of thousands of the best of our teachers, men and women of originality and power.

"The educational process is not the mechanical impact of text-books or even of ideas upon the intellect, but the impact between living beings; and in the interaction vastly more is given and received than is ever formulated. What the teacher is expresses itself; and always the teacher's personality is the greatest educational influence."[8]

Such teachers, thinking men and women, devoted to their life calling and their subject, imbued with the same enthusiasm which their students possess are far better qualified to judge on the fitness of secondary school courses than the university professor, the man of research and too often of but that one idea.

Granted that our secondary school science courses are not yet attaining their greatest opportunities; that in the past university ideas and ideals have so impressed themselves upon the secondary school that the term "preparatory school" has become one of opprobrium, then what can the science teacher do to remove this stigma?[9]

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[7] "Biology in Secondary Schools," Caldwell, "School Science and Mathematics," 1909, p. 591. What is your opinion of the proposed introduction of economic, industrial and agricultural materials into the courses in botany and zoölogy?

Those approving are,	20
Those disapproving are,	5
Those partially approving but strongly expressing doubts in some form,	17
Indefinite or not answering,	7

[8] "Educational Review," Oct. 1908, p. 295.
[9] F. Whitten, "School Review," 1900, p. 261.

The answers given above sound the keynote of the reply. Let us make our work in science more practical and practicable. We can teach the great truths of chemistry, physics or biology without going far afield for our material. The need for the understanding of simple chemical and physical principles in their application to everyday life are constantly before us: the need for civic biology in our great cities to-day was never more pressing; the need of impressing the truths concerning conservation is just as great for our rural children.

In a recent article entitled "How the Public will Solve our Problems of Science Teaching,"[10] Professor John F. Woodhull of Columbia University gathers together material collected from several score of witnesses, all of whom arraign the public high school as now administered as a "select" school dominated by the college. "The public," he says, "will demand that science instruction shall be more practical or as Prof. Bailey puts it—more *applicable*." He goes on to say that he believes within a few years' time science will have become greatly humanized; and quotes several teachers' physics clubs as putting themselves on record for "teaching physics not as a preparation for college but as a preparation for life."[11]

Professor Bailey has long stood as an exponent of practical nature study. We who are familiar with the results he has accomplished in New York State know full well the value of his practicality. Professor C. F. Hodge, a reformer who has done perhaps more than any other one man to make elementary nature study practical, in a recent article[12] drastically ridicules certain college entrance examination papers in botany and zoölogy, by showing how far from the daily life of the pupil such questions and problems were. Some of the questions he suggests in their place are worthy of careful scrutiny by the university graduate who begins secondary school teaching with university ideals for his credo. The summary of a recent report presented by a committee of the New York High School Teachers Association[13] expresses well the sentiment of a large body of teachers and is worthy of note:

"Biology contains in organized relation many applications to human

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[10] "School Science and Mathematics," 1909, pp. 267-280.
[11] F. B. Spaulding, "School Science and Mathematics," 1908, p. 674.
[12] "Civic Biology, a High School Science Devoted to Community Welfare and the National Life," "Pennsylvania School Journal," Feb. 1909.
[13] "The Practical Use of Biology," H. R. Linville and others, "School Science and Mathematics," 1909, pp. 121-130.

life. Many of these applications would never be developed in other subjects of the high school course.

"It is of vital consequence to the nation that its citizens understand the importance of preserving its natural resources for future generations of men.

"It is of more consequence that the young realize the need of guarding its greatest resource—the health of the people. The comprehension of man's place in nature and the interdependence of all creatures of nature, contributes to satisfaction in living, and it offers a scientific basis for the work of preserving the public resources.

"The methods of biology give a good opportunity for training in habits of mental accuracy by the scientific method of thought applied to problems of real life."

Courses in biology based upon such underlying foundation stones as these, the general principles of biologic science which give rise to the laws which govern human society, the factors of environment which react alike upon plants and animals, the conservation of the natural wealth of our nation, that most important topic of national health and vitality, the too often slighted teaching of the personal application of the rules of morality and health as codified in the teaching of personal hygiene, not forgetting meantime that biology stands for discipline and culture in its broadest sense: these are the foundation stones upon which we must build our future secondary school courses in biology.

STUDYING BUDS.

What do we expect to accomplish by the dissection of buds in the high school course in botany? Are we after fundamentals or are we simply "studying buds"? A good many teachers seem content to assure the pupils that there are three types of buds: leaf buds, flower buds and mixed buds containing both flowers and leaves; but a good teacher will not stop here. The average pupil has an idea that all buds contain flowers and it may require some little effort to convince him that the leaf bud is far more abundant than any of the others and that even this does not produce leaves merely, but a young twig as well.

Then there are growing buds and resting buds, the latter often with scarcely more protection than the growing buds, though usually such buds are well protected by bud scales. If we are after the fundamentals, we shall have to show that the bud scales are really transformed leaves or parts of leaves,

decide what becomes of them when the buds begin to grow and examine various methods which plants have evolved for protecting these growing points through the winter.

A lilac bud is one of the best for showing that the bud scales are transformed leaves. The transition from the scaly parts without to what are clearly leaflike parts within is so gradual that the most stupid pupil can see and understand. In a second type of bud, the scales have gone too far on their way ever to be able to function as leaves, and when spring comes they fall off, leaving a circular scar around the twig. This scar is not noticeable in plants like the lilac, in which even the bud scales become leaflike. As an illustration of the second type of bud, the horse chestnut is usually suggested, but in many localities a better one may be found in the buckeye. The glue-like covering of the horse chestnut's bud scales is of interest as illustrating an additional device for protecting from evaporation, but this same sticky substance prevents a proper dissection of the bud by beginners. In addition, the young leaves in the bud are so heavily coated with hairs that it is difficult to make out their parts. This cannot be said of the buckeye. The leaves are downy, it is true, but not enough so to obscure the parts, and the bud scales are quite devoid of the varnish.

Among curious methods of bud protection, nearly every text cites that of the sycamore or buttonwood, in which the bud is said to be protected by the petiole of the leaf. This, however, is not a real protection to the bud in winter inasmuch as the leaf falls in autumn. It simply protects the young bud until maturity. There are other plants easily obtainable, however, in which the petiole really protects the bud through the winter. The common red raspberry, the flowering raspberry and the cat brier or smilax may be mentioned as good types of this. In these, instead of the leaf being cut off at the base, a cleavage plane develops at some distance above the bud and when the rest of the leaf falls the petiole stub remains subtending the bud.

It is often difficult for the teacher to find suitable material to illustrate the arrangement of accessory buds. The red maple is often suggested for the type having the accessory buds beside the lateral or auxiliary buds, but this tree is not always to be found nor does it illustrate the phenomenon any too well. The peach, the forsythia and some oaks are usually as easy to

obtain and show the arrangement even better than does the maple. For that form of bud arrangement in which the accessory buds are arranged above the lateral buds, the pipe-vine and Pterocarya are often suggested. A good many teachers are not familiar with these, but just as good material for this work may be obtained from vigorous young twigs of walnut or butternut, the latter by preference.

Witch hazel is a fine type of naked bud when it can be obtained, but if it is not at hand the papaw, butternut and many of the viburnums, especially the cultivated ones, will do. In this connection it should not be forgotten that there are many buds not protected by bud scales which are not usually named as naked buds but which are essentially such. Buds like those of the catalpa, sumac and ailanthus are, at the beginning of winter, scarcely more than mere living points, half buried in the bark of the twigs, but later in the season they will show their character. For class work these should not be used if better things can be obtained.

Probably the most important facts about buds from the pupil's standpoint are the ways in which they are arranged on the twigs, what they produce and how and from what they are protected. It is well to emphasize the fact that buds do not protect from cold, for the moisture in them is often frozen solid during the winter. Yet nine persons out of ten one meets is sure that the chief use of bud scales is to protect from the cold. In this they draw an analogy from their own clothing, forgetting that the warmth is supplied to our clothing by the heat of the body. That bud scales may protect from sudden changes of temperature, no one can deny, that their color may aid in warming up in spring is possible, but the real uses of bud scales seem to be to protect from complete evaporation, mechanical injury and decay. C. N. W.

Lime is added to cement mortar for economy, and physical tests show that in quantities less than 15 per cent the cost of the mortar is reduced more rapidly than the indicated strength, and is therefore economical. But addition of lime is equivalent to over liming in the manufacture of cement, developing the fatal defect of gradual disintegration. This would seem to be due to the carbonation of the lime, causing expansion, which breaks up the imbrication of the crystals, which is what constitutes the "set" on which the strength of the cement depends.

THE DROP-METHOD OF MEASURING SURFACE TENSION.

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Qualitative illustrations of surface tension phenomena abound so that there is no lack of material for the experimental study of this, to most pupils, fascinating field. But when it comes to measuring the amount of tension, difficulties arise, for in all methods, a clean surface is required, and a clean liquid surface is one of the hardest things to get and still harder to maintain. For secondary schools, the capillary tube method is altogether too elaborate and difficult, at least, if properly performed. The film method as described by Edwin H. Hall (this journal, Vol. IX, p. 759) is simple and direct enough, and in a slightly different way (an improved spiral spring balance and a saddle shaped strip of metal being used) I have had my students employ the method for a number of years. The drop method, however, I have finally adopted, mainly because it gives uniformly accurate results, requires very simple apparatus and manipulation, and seems to be within the comprehension of most students.

Theory of the Method. When a liquid issues in drops from a vertical tube whose radius is r, each drop clings to the tube and does not fall off until its weight w just exceeds the tension of the surface of the liquid around the circumference of the tube. Denoting by T the surface tension (grams per centimeter), we have then

$$w=2\pi rT.$$

As the measurements of the tube's radius cannot be carried out satisfactorily with the instruments commonly available in secondary school laboratories, the method has to be made relative rather than absolute. If the same tube be used with another liquid, we have

$$w'=2\pi rT',$$

and, by division,

$$\frac{w'}{w}=\frac{T'}{T}$$

If we know the surface tension of some standard liquid, say water, weighings of drops coming under similar conditions from one and the same tube will enable us to find the surface tension of a second liquid.

It should be added that the above formula is not strictly true, as a small proportion of a drop always clings to the tube, so that the weight of the detached drop is a little less than that called for by the formula. While it is possible to determine the weight of this remnant, it is hardly practicable to have it done by high school students. Rather is it better to so choose the liquids that the weights of the drop remnants are practically in the same ratio as the weights of the detached drops, as, in that case, the ratio of the falling drops remains the same despite the circumstance that some of a drop remains clinging to the tube. I have found by using water as the standard liquid and aqueous solutions as the liquids to be tested that the influence of the remanent drop is negligible.

Practice of the Method. A bottle of any convenient size is fitted with a cork pierced with two holes. Through one of these holes passes an L-tube and through the other a siphon. A piece of rubber tubing is slipped over the L-tube and may be pinched together by a Hoffman clamp. In lieu of a clamp a small hole or slit may be cut in one side of the rubber tubing and a glass rod shoved in so as to reach past the opening. By moving the rod so as to expose more or less of the opening a nice adjustment of the amount of air admitted into the bottle may be secured. The bottle is filled with the liquid to be tested and the siphon set in action by blowing through the L-tube. By adjusting the clamp the speed of flow through the siphon may be easily regulated or the flow stopped entirely.

At the end of the outer arm of the siphon is attached by means of a bit of rubber tubing a burette tip. As most liquids wet glass, there is a tendency for them to creep up around the sides of the tube so that the drops become irregular in size. By coating the tip of the tube with wax (beeswax, paraffin or similar substances) this wetting does not take place in the case of liquids not dissolving the wax, and the drops are remarkably uniform in size and weight. To prepare such a jet tube, draw out a piece of glass tubing to small diameter in a flame, make a file scratch at the middle of the constricted part, warm a little and rub with wax. Twirl the tube around while it cools so as to cover it with a thin and uniform coating of the wax. When the tube is cold, bend it a little and almost invariably it will break squarely off at the scratch, thus making two jets of equal size with a sharply defined wax coating at their orifices.

The bottle is set up on blocks or on a stand so that the tip is high enough for a beaker or tumbler to be placed under it to catch the drops. Adjust the clamp so that the drops form at the rate of about one a second and then catch in a weighed beaker or other suitable dish a hundred drops or so. Weigh the dish and the water collected, and, without emptying it out, catch another lot of drops. As many lots can be caught and weighed as time permits. The weight of a counted lot of drops divided by their number obviously gives the weight of a single drop.

The same tip may now be transferred to a second bottle containing a salt solution, and the weight of a counted number of its drops found as above. The other tip from the same piece of glass tubing may be used, if its identification is sure. I have found it easier to have each pupil use one and the same tip instead of trying to keep track of the tips of equal size. The change of a tip from one bottle to another takes but an instant.

Precautions and Results. The chief precautions to be observed are that the drops are not formed too rapidly and that the same speed of formation is maintained in each trial. While adjusting the speed of formation the drops should be caught in a dish to prevent wetting the table. The drops should be made to strike the sides of the receiving vessel so as to avoid loss from spattering.

I have used in my classes 10 per cent solutions of sodium chloride, ammonium chloride and copper sulphate, as these are familiar and readily obtainable substances. Of course, any others may be chosen. The more accurate the weighings, the more accurate, naturally, the determinations. But if the balances used are capable of weighing only to tenths of a gram, accurate results may nevertheless be obtained by counting out large number of drops. The loss from evaporation, while slight, still necessitates that the weighings be made promptly after the drops are caught.

The accuracy of the method is surprisingly great. If the temperature of the room remains practically constant, the weights of a hundred drops taken in succession are practically the same. But as surface tension varies not inconsiderably with the temperature and as the temperature of the liquids is not regulated by any special means, differences will usually be found. The method is a research method and with proper conditions is capable of yielding very accurate results.

When a class has completed the experiment, the liquids may be drawn back into the bottles out of the siphons and the clamp at the L-tube closed. The apparatus may then be stored and is ready at a moment's notice for use with the class of the following year. I have used the same apparatus without change or refilling for three successive years with large classes, keeping dust off the bottles during storage by covering them over with paper bags. The only renovation then required was fresh rubber tubing and liquids.

The total production of refined lead, desilverized and soft, from domestic and foreign ores in 1909 was approximately 444,363 short tons, worth at the average New York price $38,215,000, as compared to a production of 396,433 tons in 1908 and 414,189 tons in 1907. These figures do not include an estimated output of 12,860 tons of antimonial lead, as against 13,629 tons in 1908 and 9,910 tons in 1907. Of the total production, desilverized lead of domestic origin, exclusive of desilverized soft lead, is estimated at 209,698 tons, as against 167,790 tons in 1908; and desilverized lead of foreign origin comprised 87,379 tons, compared with 97,761 tons in 1908. The production of soft lead from Mississippi Valley ores is estimated at 147,286 tons, as compared with 130,882 tons in 1908, and 129,607 tons in 1907. Missouri apparently retained first place among the lead-producing States.—*U. S. Geol. Survey.*

The total production of quicksilver in the United States in 1909 was 20,425 flasks of 75 pounds each, valued, at the average New York price in 1909, at $943,022. A comparison of these figures with those given for 1908—19,752 flasks, valued at $824,146—shows an increase for 1909 of only 673 flasks, but an increase in value of $118,876. Prices have steadily risen during the last three years, and unless production should greatly increase will probably remain fairly attractive to producers that are operating at reasonably low costs. In 1907 the average prices per flask for quicksilver were, for New York, $41.50; for San Francisco domestic, $39.60; and for San Francisco export, $38.17. In 1908 these prices rose, respectively, to $44.84, $44.17, and $42.54. In 1909 the corresponding prices rose further, to $46.17, $45.33, and $43.33. The production by States shows a decrease in California from 16,984 flasks in 1908 to 15,700 flasks in 1909; an increase in Texas from 2,832 flasks in 1908 to 3,925 flasks in 1909; and an increase in combined output from Nevada and Oregon from 346 flasks in 1908 to 800 flasks in 1909. In 1909, for the first time in many years, there was a small production in Nevada, but no production was reported from either Arizona or Utah. —*U. S. Geol. Survey.*

A THERMOSCOPE AND ITS USES.

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(Continued from January issue.)

47. Solution of Electrolytes of the Same Molecular Concentration Have the Same Elevations of the Boiling Point.

Use the solutions made for Ex. 34 and with them repeat Ex. 46. The elevation of the boiling point of both solutions is practically the same and equal to the depression of the freezing point previously determined. See Note to Ex. 34.

48. The Elevation of the Boiling Point of a Solution Is Twice as Great for Electrolytes as for Non-electrolytes of the Same Molecular Concentrations.

Repeat Ex. 46, using the solution made in Ex. 35. Approximately the same elevations of the boiling point are produced for both solutions, which are equal to the depressions of the freezing points previously determined. See note to Ex. 35.

C. CHANGE OF CONCENTRATION.

49. Cooling Produced by Diluting the Solution of a Salt, viz., by Increasing the Ionization.

In (3) place about 5 cc. of a saturated solution of NH_4NO_3. Note the indicator reading and then add about 15 cc. of water having the same temperature as the solution.

50. Heat Produced by Mixing Alcohol and Water, viz., by the Resulting Concentration of Volume.

Carefully fill (3) one half full of water and then add alcohol so that little mixing results. Read the indicator and then stir the liquids, causing them to mix.

51. The Solution of a Salt Occupies Less Space than the Volume of Solute and Solvent.

Fill a bottle about one half full of water and float on it a Meissen crucible containing a considerable amount of some soluble salt. Connect the bottle to the thermoscope and read the indicator. Sink the crucible and allow the salt to dissolve. The indicator will lower, due to both solution and concentration of volume, but after the temperature of the water reaches the previous room temperature the indicator will still be lower than at first.

Note. These and other experiments seem to show that when there is a change of concentration of the volume not accom-

panied by secondary action (ionization, chemical action, etc.,) there is a liberation of heat on changing to a greater concentration and an absorption of heat on increased dilution, or change to a more fluid condition.

D. Solution and Precipitaton.

52. Cooling by the Solution of a Solid.

Connect (3) and partially fill with water. Add NH_4NO_3 and stir gently.

53. Heating by the Precipitation of a Solid in a Solution.

Connect (3) and fill with a hot saturated alum solution. Allow the solution to cool and then adjust the indicator to zero. Throw several fine crystals of alum into the solution, so that the crystallization begins, and note the elevation of the indicator.

Specific Heat.

54. Different Substances Have Various Heat Capacities.

Connect both (3) and add equal volumes of water. Place in each bulb equal weights of two metals that were heated in the same source, such as a beaker full of hot water. The equilibrium is at once destroyed, as the two different metals have different heat capacities, or specific heats.

55. Determination of the Specific Heat of Solids.

Connect the two (3) and place 15 cc. of water in each. Heat a 50 g. brass weight in a beaker full of water. Place the hot weight in one bulb and add the hot water to the other until equilibrium is restored. An approximate value of the specific heat will be given by the ratio of the weight of the hot water to the brass.

56. Determination of the Specific Heat of Liquids.

Connect both (3). Partially fill them with the same weights of water and the liquid whose specific heat is desired. Heat two 50 g. weights in a beaker of boiling water and place them in the two bulbs. The liquid of the smaller sp. ht. will have the greater elevation of the indicator. The sp. ht. is the ratio of the two indicator elevations.

57. Dulong and Petit's Law that Sp. Ht. $\times$ Atomic Weight = Approximately a Constant (6.2).

Connect both (3) and place 15 cc. of water in each bulb. Take 56 g. of iron and 69 g. of zinc, viz., masses proportional to the molecular weights of the metals used. Heat both in a

beaker of water. Immerse the two weights in the water of the bulbs and note that the equilibrium is retained.

Sp. Ht. $\times$ Atomic Weight = Sp. Ht. $\times$ Atomic Weight = Constant.

Ebullition and Vapor Pressure.

58. The Temperature of a Liquid Remains Constant at the Boiling Point.

Attach (1) and immerse in a beaker of water. On heating the water the indicator will rise until the boiling point is reached. It will then remain constant while the water is boiling.

59. The Temperature of the Vapor of Boiling Water Is the Same as that of the Liquid.

Place an air thermometer bulb in a hypsometer partially filled with water. Hold the bulb alternately in the boiling water and in its vapor. The indicator remains constant.

60. The Temperature of the Vapor of a Boiling Solution Is Lower than that of the Liquid.

Repeat Ex. 59, using a strong solution of some salt instead of pure water.

61. The Boiling Point of a Liquid Diminishes with the Reduction of the Pressure and Vice Versa.

Immerse an air thermometer bulb in the steam of water of a hypsometer and boil. Connect an aspirator and reduce the vapor pressure. The liquid boils at a lower temperature. Remove the aspirator and stopper up the escape tube. The boiling point increases.

62. The Temperature of the Vapor of a Boiling Solution of a Salt in Water Is the Same as that of Pure Water.

Partially fill one hypsometer with water and another with some salt solution. Place two air thermometer bulbs of equal capacity above the liquids and connect in opposition to the thermoscope. Boil each liquid under the same pressure. The temperature of the two vapors is the same.

Radiant Heat.

64. Reflection of Radiant Heat. $\angle i = \angle r$.

Reflect the heat rays emitted from some hot body, such as a small sheet of metal with a flame playing behind it, from a polished plane metal mirror. With (2) locate the direction of the reflected heat. $\angle i = \angle r$.

65. Effect of the Surface of the Radiating Body.

Take a Leslie cube having smooth, rough, lacquered, and blackened faces. Fill the cube with hot water and place (2) alternately the same distance from the four faces. Note the indicator reading in each case.

66. Difference in Rate of Cooling of Blackened and Unblackened Surfaces.

Take two bottles of equal size and cover one with soot. Add to each the same volume of equally hot water. Connect both (4) to the thermoscope and immerse in the bottles. The blackened bottle will show the more rapid cooling.

One bottle can also be covered with white paint or varnish to illustrate that it is not necessarily a black surface that radiates rapidly.

67. To Prove that the Non-luminous is Hotter than the Luminous Bunsen Flame.

Suspend 1 g. weights of the same metal in each of the two flames and when hot place in the two (3) connected in opposition and containing the same volume of water.

68. The Radiation from the Luminous is Greater than from the Non-luminous Flame.

Connect (2) and place it about 15 cm. from a non-luminous Bunsen burner flame. When the indicator comes to rest shut off the air supply and note its elevation, caused by the increased radiation.

69. Law of Inverse Squares.

Place a 100 g. weight in the non-luminous Bunsen burner flame and heat to redness. Place (2) at various measured distances from the weight and note the corresponding indicator elevations. These vary approximately inversely as the square of the distance from the bulb to the hot weight. It is advisable to blacken the flat surface of (2) for this experiment.

70. Radiation from a Cold Substance.

Place a block of ice and (2) at the conjugate foci of a large short focus metallic concave mirror. Note the depression of the indicator.

71. Refraction of Radiant Heat Rays.

Place a very hot solid and sooted (2) at the conjugate foci of a large convex lens.

72. Metals Have Poor Radiating Surfaces.

Fill a Leslie cube with hot water. Place it about 10 cm. from

(2). First expose the plain metal side and then those that are painted, sooted, or lacquered. The radiation from the metal surface elevates the indicator less than that from the prepared sides.

73. Radiant Heat Travels through a Vacuum.

Suspend a heavy, very hot metal in a small bell jar and place on an air pump receiver. Attach sooted (2) and hold near the bell jar. Exhaust the air when the indicator has reached equilibrium. No change is noticeable.

74. Newton's Law of Cooling.

Connect to the thermoscope, in opposition, two bottles of the same size and surface conditions and containing equal volumes of water at markedly different temperatures. The hotter liquid cools at a more rapid rate.

Absorption of Radiant Heat.

75. Effect of the Surface of the Absorbing Substances.

Place a hot metal weight midway between the two (2), one being clean and the other blackened. The blackened bulb is the better absorber.

76. Equality of the Radiation and Absorption Coefficients.

Blacken one side of a large bottle and fill it with hot water. Also blacken the flat side of one (2), keeping the other one clean. Place both (2) 10 cm. from the bottle with the sooted side of (2) facing the clean side of the bottle and vice versa for the other bulb. The indicators will rise to approximately equal heights.

77. Selective Absorption of Different Media.

Place sooted (2) in the path of sunlight and hold in the path of the beam differently colored glasses, mica and tanks of water and of a solution of iodine in carbon bisulphide. Note the various thermoscope readings. Although the iodine solution is opaque it produces a greater indicator elevation than when the water is held in the path of the light. The iodine absorbs the light and transmits the heat waves, while just the opposite obtains for water.

78. Different Temperatures of the Absorbing Media.

Hold the substances mentioned in the last experiment in the sunlight for some time and then place them against (2). The temperature of the better transmitters of heat will be found the lowest.

79. Effect of the Angle of Incidence on Absorption.

Place a hot weight and (2) at the conjugate foci of a mirror and change the angle of incidence of the bulb gradually from 0° to 90°. Note the different thermoscope readings.

80. Mechanical Equivalent of Heat.

Attach (1) and rub vigorously with a flannel rag. Also pound a nail, or shake a bottle containing about 200 g. of mercury. Place these in (3).

The experiments previously given on the heating of gases by compression and cooling by expansion are examples of the conversion of mechanical energy to heat and vice versa. In one case work has been done on the gas while in the other it performs work and cools.

ELECTRICITY.

81. Production of Heat in a Voltaic Cell.

Partially fill (3) with dilute H_2SO_4. Introduce electrodes of Zn and carbon, being careful that these do not come in contact. But little heating is produced. Close the circuit and note the rise of temperature.

82. Local Action.

Place a piece of amalgamated Zn and carbon in (3) filled with dilute H_2SO_4. Keep these out of contact. Read the indicator. Replace the Zn by a piece that has not been amalgamated. Extra heating is produced.

83. Heat Produced by the Electric Current.

Place a coil of wire in (3). Cork up the opening of the tt. and run a current through the coil.

84. The Heat Produced Varies as the Resistance.

Make two coils of wire, one of which has exactly twice the resistance of the other. Connect both (3) and add 20 cc. of kerosene. Introduce the coils and connect in series with a battery. The shorter coil produces but one half the heating of the larger one.

85. Heat Produced by the Electric Current Varies as the Square of the Current Strength.

Take two coils of resistance R and 4 R and place them in the two (3) partially filled with about 20 cc. of kerosene. Run a current C through the 4 R coil and a current 2 C through the R coil. The thermoscope will remain in equilibrium.

86. The Resistance Varies as the Length of the Conductor.

Make two coils of the same kind of wire, one of which has exactly twice the length of the other. Connect both (3) to the thermoscope and add 20 cc. of kerosene to each. Introduce both coils and connect in series with a battery. The elevations of the indicator will be as 1 : 2.

87. Resistance Varies Inversely as the Cross Section of the Conductor.

Take two wires of the same length and material, but of different known cross sections. Repeat Ex. 86. The elevations of the indicator will vary inversely as the cross sections of the wires.

88. Temperature Coefficient of Resistance.

Place a coil of copper wire of about 50 ohms resistance in an oil bath and connect in series with a battery and a smaller coil placed in (3) containing 20 cc. of kerosene. Adjust the current so that the indicator rises several centimeters. Heat the oil bath and the indicator will lower.

89. Specific Resistance.

Make two coils of the same length and cross section, but of different metals. Place these in the two (3) containing 20 cc. of kerosene. Connect the coils in series with a battery and note the different elevations of the indicator.

90. Transformation of Electrical to Mechanical Energy.

Connect a battery, a small motor and one of the heating coils in series. Place the coil in (3) containing 20 cc. of kerosene. When equilibrium is obtained note the indicator reading. Slow up the motor by holding the hand against the pulley, or stop it entirely. The heating at once increases, but diminishes again when the motor is allowed to run freely.

91. Lines of Flow in a Conductor.

Attach two wires to the opposite sides of a thin sheet of metal and run a heavy current through it. Close a thistle tube on top so that its face is flat and attach it to the thermoscope.

Hold the top flat surface against various parts of the sheet and plot the lines of equal heating, viz., the lines of flow in the conductor.

92. Peltier Effect in Thermo Electric Couples.

Take a Melloni pile and pass a small current through it. Attach (2) and hold it alternately against the two faces of the pile. One indicates a heating and the other a cooling effect. The side that is cooled is the one that must be heated to produce

a thermo electric current in the same direction as the battery current.

Chemical Reactions.

Chemical reactions of every character are accompanied by some heat effect. They are generally exo-thermic, in which case heat is liberated, but sometimes endo-thermic, in which case heat is absorbed and the surrounding media cooled. The reactions can all be performed conveniently in the tt. of (3). Only a very few of these experiments will be outlined:

93. Heat Produced by Chemical Solution.

Connect (3) and add a few cc. of dilute HCl. Drop into the acid a few pieces of Zn.

94. Heat Produced by Combustion.

Attach (3). Place a little melted sulphur on a glass rod. Ignite and lower into the bulb.

95. Heat Produced by the Reaction of Na and Cl.

Attach (3) and fill it with Cl gas. Drop a piece of clean Na in the tt.

96. Slow Oxidation of P.

Fill tt. of (3) with O by Hg displacement. Introduce a piece of P and connect to the thermoscope.

97. Heat of Neutralization.

Connect (3) and add a few cc. of some acid. Neutralize with a base and note the elevation of the indicator.

These few experiments illustrate the usefulness of the thermoscope. Many more could be added by any ingenious teacher. The thermoscope and accessories have recently been put on the market by the Central Scientific Company, 345-349 West Michigan St., Chicago, Ill.

In most masonry specifications is found a clause specifying that the sand for mortar or concrete shall be clean. But the results of tests of mortar to which large portions of loam or clay have been added have often been higher than those of mortar made with cement and pure sand. It is believed to be impossible to make a general statement in this regard, as in some cases it is a benefit and in others a detriment, depending upon the richness of the mortar and the coarseness of the sand. Lean mortars may be improved by the presence of loam or clay or the use of dirty for clean sand, because the fine material increases the density.

MEASURING INSTRUMENTS OF LONG AGO.

By William E. Stark,
Ethical Culture School, New York.

(Continued from January issue.)

The Cross-Staff.

The cross-staff *baculus,* called also the Jacob staff, in its simplest form was a rod of rectangular cross section about four feet long with a short crosspiece having a square hole in the middle. This hole fitted the rod snugly enough to keep the crosspiece at right angles to the rod but not too tightly to prevent its position being changed.

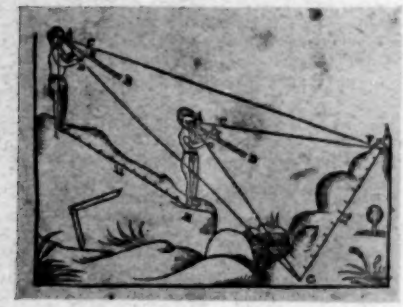

Figure XXVII
The Cross-Staff in Use.
From Finaeus.

The staff was marked off into sections equal in length to the crosspiece.

The instrument was used for measuring dimensions of inaccessible objects such as a fort (Figure XXVII). The crosspiece was first placed at one of the division marks of the staff. The observer then took a position opposite the middle of the line which he wished to measure, and moved forward or backward until when one end of the staff was placed at the eye, the crosspiece just covered the object. The crosspiece was then moved to the next division of the staff, and the observer took such a position that the object was again exactly covered. The required distance was obtained by measuring from one point of observation to the other.

Fiammelli[4] says that Finaeus and Bartoli, who speak highly of the *baculus,* were mathematical theorists and not practical workmen and that their claims are not justified. He says that it is often impossible to get observations from points as far apart as the length of the required line and gives a general rule for calculating the desired dimension from two observations and the distance between them.

His rule is to multiply the distance between stations by the

[4]La Riga Matematica di Gio. Francesco Fiammelli, Florentino Matematico, Rome. 1605.

fractional part of a cross-bar length between the two settings of the cross-bar. To obtain the latter factor with accuracy, he proposes that the principal spaces on the staff be each divided into one hundred parts.

The verification of Fiammelli's rule and of the special relation referred to by Finaeus are valuable student's exercises.

Sector Compasses.

The sector compasses or sector (*compas de proportion*) combined in a single small instrument the means of solving a great variety of problems in arithmetical and geometrical proportion. It was used by architects, surveyors, military engineers, and practical mathematicians generally. It was made in various sizes and some examples were of beautiful workmanship. The earliest description of the sector which I have found is in Bettinus' Apiaria[5], 1645, although it is said to have been invented nearly a century earlier[6]. Though still listed in the catalogues of dealers, this device, which maintained its utility for two hundred years, appears to have been almost completely forgotten.

The instrument consisted of two metal rules, usually about six inches long, joined by a hinge like the common two-foot rule. (Figure XXVIII.) From the center of the pivot six pairs of lines radiated, three on each face of the instrument. The lines were graduated, the two members of each pair, one on each rule, being in symmetrical positions and marked with identical divisions. (Figure XXIX.)

On one face of the sector of the eighteenth century were the lines of equal parts, the lines of squares, and the lines of polygons. On the other, the lines of chords, the lines of cubes, and the lines of metals. On the first face also there was usually a scale giving the caliber of cannon corresponding to the weight of the ball, and in a corresponding position on the other face a scale of diameters of bullets of given weight. Lines of sines, of tangents, and of secants were added at a later period.

In the instrument as described by Bion each line of equal parts was divided into two hundred segments and numbered beginning at the hinge. To divide a line into any number of equal parts, for example seven, take the length of the line on a pair of dividers and, placing one point of the dividers on the point

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[5]Apiaria Universae Philosophiae Mathematicae. Marius Bettinus of Bologna and the Society of Jesus. Bologna, 1645.

[6]International Encyclopedia. Article on Sector.

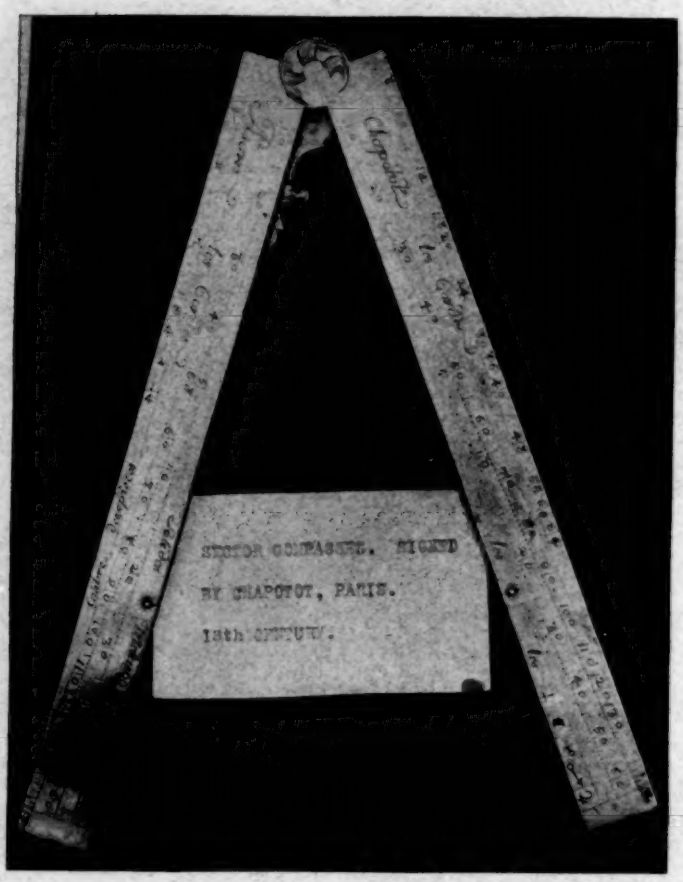


Figure XXVIII.

SECTOR BELONGING TO PROFESSOR DAVID EUGENE SMITH OF TEACHERS' COLLEGE, NEW YORK.

marked 70 or 140 on one line of equal parts, open the compass until the other point of the dividers touches the same number on the other line of equal parts. Then the distance from one 10 (that is from the point marked 10 on one of the lines of equal parts) to the other is one seventh of the line, from 20 to 20 two sevenths, and so on.

The foregoing problem will suggest at once the utility of the instrument in drawing to a scale or in measuring distances taken from a map, whose scale is given. The only other problem for the line of equal parts which I shall mention is that of finding a

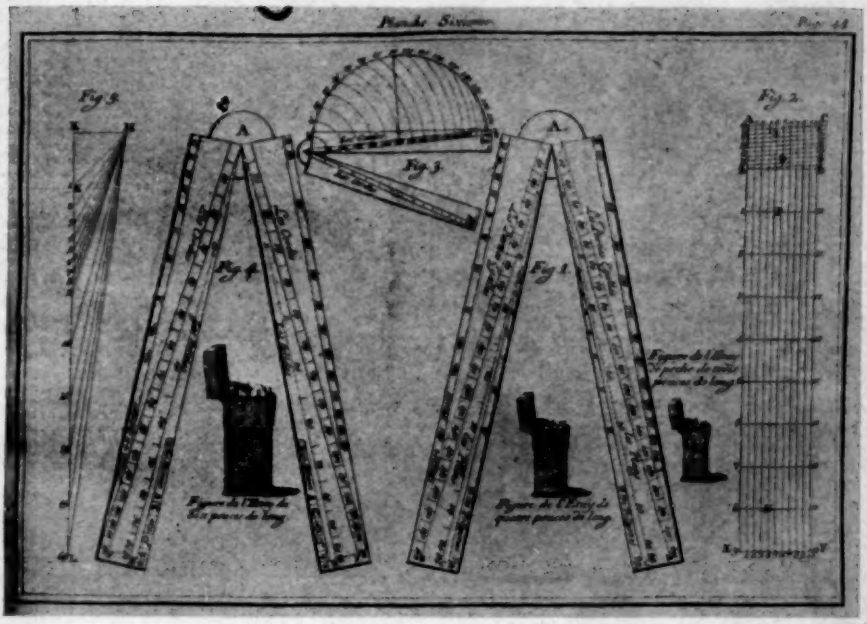


Figure XXIX.

SECTOR COMPASSES. FROM BION.

straight line of the same length as the circumference of a given circle. To do this take the given diameter in a pair of dividers and set the compasses so that the dividers span from 50 to 50. The distance from 157 to 157 is then the length of the required line.

The line of squares is simply a scale of square roots, that is, the distance from the pivot to any point on the scale is proportional to the square root of the number standing opposite the point. To find the side of a polygon whose area is three-fifths of that of a given similar polygon, set the compasses so that the distance from 50 to 50 on the line of squares is equal to the side of the given polygon. Then the distance from 30 to 30 is the required line. Other problems to be solved by the line of squares are (1) to determine the ratio of areas of two given similar polygons, and (2) to construct a polygon similar to two given polygons and equal to their sum or their difference.

The method of laying out the line of squares is a good application of the Pythagorean proposition. (Figure XXIX.) A

line KL is drawn equal in length to the proposed line of squares. This is divided into eight equal parts and the points of division numbered 1, 4, 9, 16, 25, 36, 49. The end of the line is numbered 64. At K, the zero end of the line, a perpendicular KM is erected equal to one of the eight parts just referred to. Then the distance M1 is taken in the dividers and laid off on the line from K. The point found is numbered 2. The distance B2 is then laid off from K giving a point which is numbered 3. In general the distance from K to any point is equal to the distance from M to the preceding point.

The line of polygons gives the relative lengths of the sides of regular polygons inscribed in the same circle. As an example of the use of this line, let it be required to inscribe a regular polygon of seven sides in a given circle. Open the sector so that the distance from the points marked 6 on the lines of polygons is equal to the radius of the given circle. Then the distance from 7 to 7 is the length of the required side and may be stepped off on the circumference with the dividers. Other problems for the line of polygons are (1) to describe a given regular polygon on a given side, and (2) to divide a given line in extreme and mean ratio.

On the line of chords (Figure XXIX, 3) the distance from the pivot to any point is the chord subtending a central angle measured by the number of degrees marked opposite the point, the whole length of the line being the diameter or the chord of 180°. To open the compass so that the lines of chords make any desired angle, for example 57°, take in the dividers the distance from the pivot to point 57 on the line of chords, and open the compasses until this distance spans from 60 to 60. Other problems are (1) to lay out any desired angle; (2) to measure a given angle; and (3) to take on the circumference of a given circle an arc of any required number of degrees.

The line of cubes is a scale of cube roots corresponding to the scale of square roots on the other face of the compasses. To find the ratio of volume of two similar solids, set the compasses so that the distance from 10 to 10 on the lines of cubes is equal to some dimension of one of the solids. Then take the corresponding dimension of the other solid in the dividers and find the reading on the lines of cubes indicated by this distance, spanned from one line to the other. The ratio of the reading to 10 of course, gives the desired ratio. The line of solids was

used to make a scale showing the relation of the weight of a bullet to the caliber of the gun which would fire it; also to divide a gauge for measuring the capacity of casks.

The distances from the pivot to the graduation marks on the line of metals are proportional to the dimensions of similar solids of equal weight made of gold, lead, silver, brass, iron and tin. Among the problems solved by use of the line of metals are: (1) to find the diameter of a ball of the same weight as a given ball, but of different metal; (2) to find the relative weight of the various metals; (3) to find the weight of a body of the same size and shape as a given body of another metal.

Map-Making Instruments.

Several ingenious instruments were devised especially for taking observations over a considerable area and recording the data in the form of maps. In most, if not in all cases the map was made "in the field" as in the case of the modern plane table. If two points on a sheet of paper are taken to represent two points on the ground, the position of a third point may be obtained by transferring to the paper, the lines of direction to the third point from the two points of observation with reference to the line between them. (Figure XXX.) Thus from two stations the relative positions of all points visible from both may be obtained, provided the direction lines do not intersect too obliquely. If the distance between the points of observation is known, any other distance may be taken from the map by scaling.

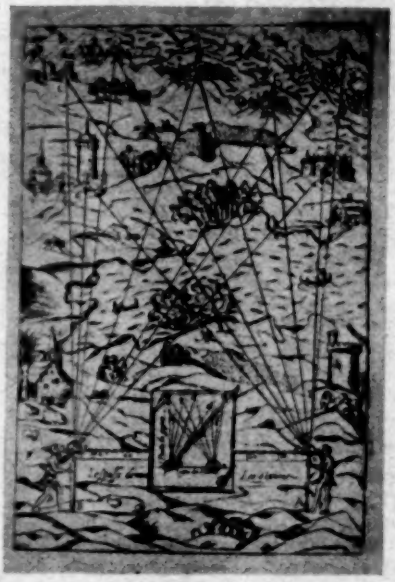


Figure XXX.

Locating Objects by Observation from a Single Base Line. From Danfrie. (See Note Under Figure VIII.)

In some instruments, the directions were obtained with ref-

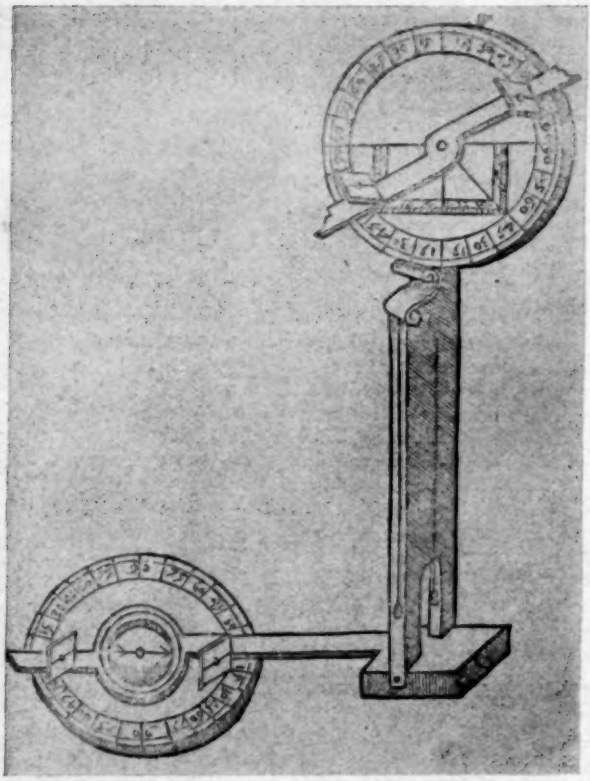


Figure XXXI.

MAGNETIC COMPASS WITH HORIZONTAL AND VERTICAL SIGHTS. FROM BARTOLI. (SEE NOTE UNDER FIGURE XXII.)

erence to the meridian by use of a magnetic needle. Figure XXXI shows a compass described by Bartoli, 1589. The vertical circle and alidade enabled the observer to take observations conveniently to points at a different level than his own, and when desired to determine the difference of elevation. The student should note the error involved when the pivot of the vertical alidade is not exactly horizonal.

The *trigometre,* invented by Philippe Danfrie and described by the inventor in a beautiful little book[7] published in Paris in 1597, enabled one to read directly from the instrument the distance from either end of the base-line to a third point. (Figure XXXII.) A rectangular bar called the base, carried at one

[7]Declaration de l'Usage du Graphometre. Philippe Danfrie. Paris, 1597.

end a pivoted rule with sights and a graduated semicircle for measuring the angle between base and rule. A second rule was attached to a clamp by means of which its pivoted end could be set at any point on the edge of the base. This rule also carried sights and graduated semicircle and both rules and base were marked with similar scales of equal parts.

The sight at each pivot could be turned so as to permit sighting either along the base or along one of the rules. Both rules could be clamped in any position on their semicircles. The whole was mounted on a tripod with adjustable joint for orienting and leveling, and carried a magnetic compass.

In practice, the instrument was set up at the right end of a base-line, and with the base horizontal and parallel to the base-line. The right rule was then aimed successively at the various points to be mapped and the angles recorded. The instrument

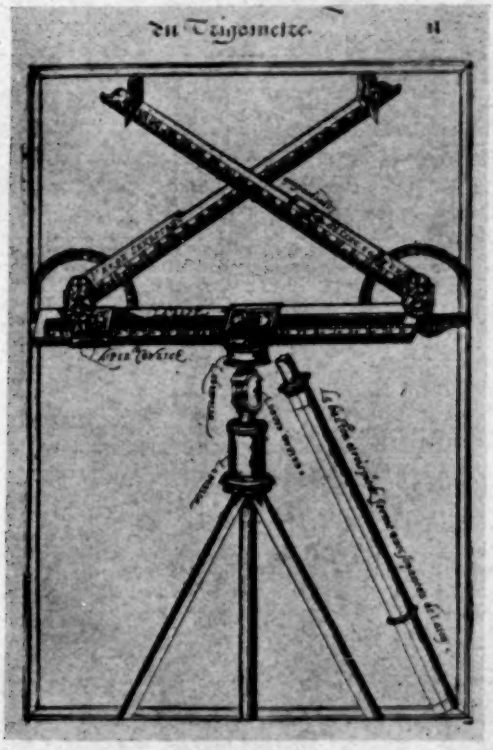


Figure XXXII.

DANFRIE'S TRIGOMETRE.

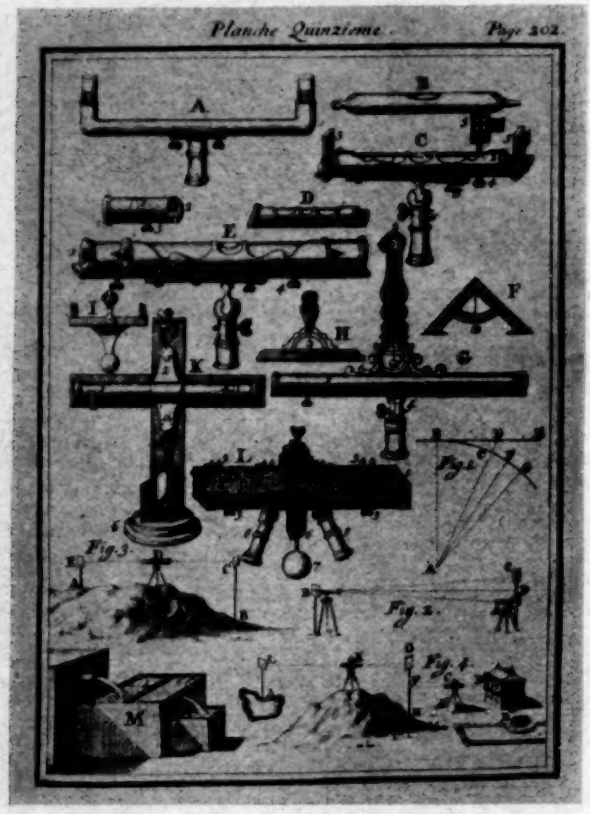


Figure XXXIII.

LEVELING INSTRUMENTS. FROM BION.

was next moved to the other end of the base-line and the base set in position by sighting back toward the first station. The left rule was now clamped in such a position that the reading on the scale of the base corresponded to the length of the base-line. With the right rule clamped at the angle previously recorded in connection with a given object, the left rule was aimed at the same object. The readings of the rules at their intersection then gave the distances of the object from the ends of the base-line. For measuring differences of elevation, the instrument was set in a vertical plane by means of the adjustable point. A pendulum attached to the right rule was used for setting this vertically.

Valletto[8], in a little book published in Venice in 1564, describes an instrument on the same principle as the trigometre which he calls a "holometro."

Leveling Instruments.

Inventors of leveling instruments made use of the free surface of a liquid, of the plumb-line, and in the later instruments, of the bubble-tube. Figures A, C, and G in Plate XXXIII, taken from Bion, illustrate the three types. Apparently all three were in use when Bion wrote.

There were numerous devices for determining a line perpendicular to a plumb-line. In a very old[9] form (Figure XXXIV), a frame like the letter A carries a plumb-line attached to the vertex. When the line hangs over the mid-point of the cross-bar, the feet of the A are in a horizontal line. The verification of this relation is a good problem for the beginner. In some forms of the instrument marks were placed on the cross-bar corresponding to the angle of slope of the line formed by the feet of the A.

Many of the devices already described could be used for projecting a level line, for example the geometric square, the quad-

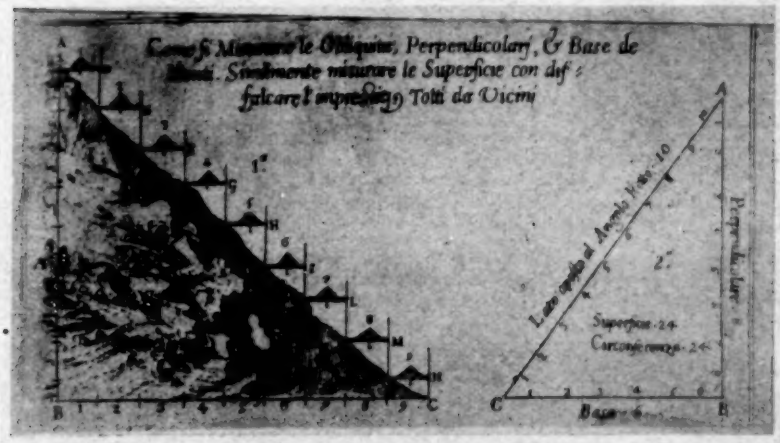


Figure XXXIV.

Leveling with a Plumb-level. From Pomodoro. (See Note Under Figure III.)

[8]Discrittione et Uso dell' Holmetro. By Abel Fullone Valletto. Venice, 1564.
[9]E. N. Legnazzi. Del Catasto Romano e di Alcuni Strumenti Antichi di Geodesia. Drucker, Verona, 1887. Plate XVII.

Figure XXXV.

LEVELING WITH QUADRANT. FROM DE JUDAEIS. SEE NOTE UNDER FIGURE VII.

rant, and the octant. In all of these, the sights could be set at right angles to the plumb-line which was an essential feature of the instrument. (Figure XXXV.) Some examples of levels of the plumb-line type were designed to give the greatest possible accuracy. The instrument (Figure XXXVI) described by Bullet,[10] architect to Louis XIV, was in the form of a figure H. One of the uprights was hollow and a plumb-line several feet long which was hung inside it was visible through a glass panel. The plumb-line was thus protected from the disturbing action of the wind. The horizontal member of the frame was at least six feet long and carried sights which determined a line perpendicular to the reference line ruled at the back of the plumb-line case. A rack on the second upright and a pinion with crank pivoted at one end of the horizontal member enabled the operator to raise or lower this end until the reference line referred to above, lay under the plumb-line. An alidade was also attached to the instrument for measuring, by means of a scale marked on one of the uprights, considerable elevations, as with the geometric square. A quadrant was also attached for measuring vertical angles which, with the aid of a table of sines, could be used in place of the vertical scale for determining heights. Figure XXXVII shows the instrument in use.

[10]Traite du Nivellement. Par le sieur Bullet. Architecte du Roy. Paris, 1688.

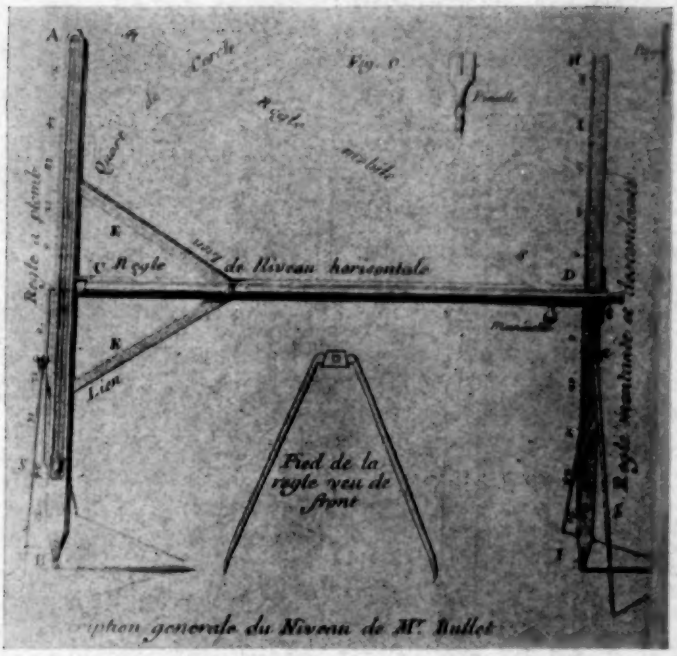


Figure XXXVI.

INSTRUMENT FOR LEVELING. FROM *Traite du Nivellement* BY BULLET, PARIS, 1688.

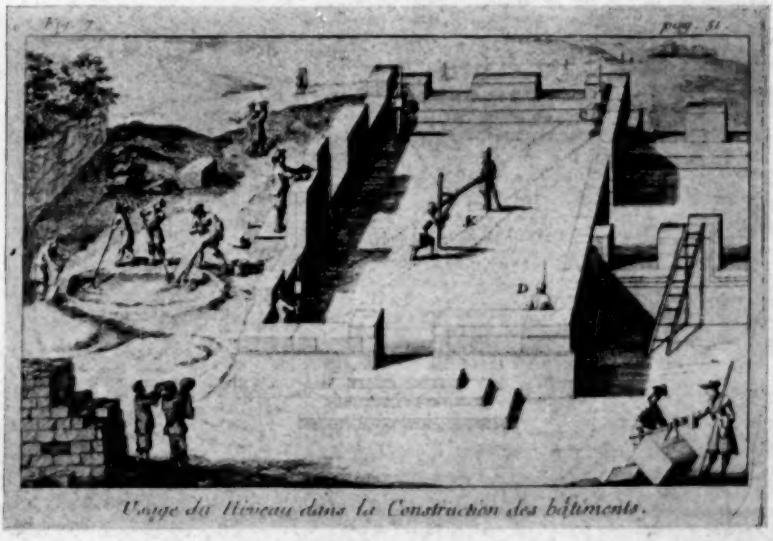


Figure XXXVII.

USE OF BULLET'S LEVEL. (SEE FIGURE XXXVI.)

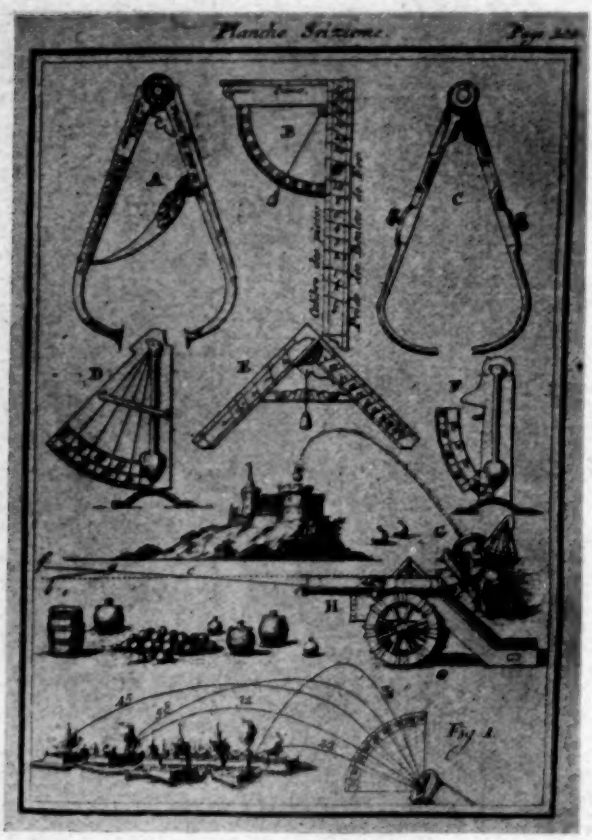


Figure XXXVIII.

ARTILLERIST'S INSTRUMENTS. FROM BION.

Bion shows (Figure XXXIII, I, K, L) a self-adjusting level of the plumb-line type, a sight being hung from a single support by means of a piece of metal carrying a heavy weight. The whole apparatus was so adjusted that the line of sight was perpendicular to a line through the point of support and the center of gravity of the instrument.

Special instruments of various forms were invented for the use of artillerists in setting cannon at any desired angle of elevation. (Figure XXXVIII.) Such instruments were often combined with scales giving the weight of iron cannon balls corresponding to various diameters or calibers of pieces. In this connection a pair of caliber compasses or calipers is shown

(Figure XXXVIII, A) as an application of the properties of similar triangles, although it has no device for measuring inclination. The jaws of the calipers end in a double set of points, the inner pair for measuring the diameter of the ball, the outer pair, the caliber of the gun. The student may show that there will be a constant ratio between these two measurements for all settings of the instrument. A metallic finger hinged at about the middle of one arm indicates on a scale on the other the weight of bullet corresponding to the opening of the points.

As stated at the beginning of this article, my purpose in describing these old instruments is to suggest applications of mathematical principles which will add to the interest and significance of the formal work of our high school courses. I have mentioned only a few class exercises which may be based on this material, but I hope that teachers who have felt the need of more concrete illustrations will find many opportunities of using these examples of the applied mathematics of a bygone day.

Hardening and tempering steel is effected by heating it to a cherry red and plunging it into a liquid, generally cold water. The degree of hardness depends on the heat and rapidity of cooling. Steel in its hardest state being too brittle for most purposes, the requisite strength and elasticity are obtained by tempering, which is performed by heating the hardened steel to a certain degree and cooling it quickly. The requisite heat is usually ascertained by the color which the surface of the steel assumes. A straw color is commonly used for cold chisels and machinists' tools.

The diamond deposits of Brazil have been worked since the early part of the 18th century, and have yielded well, although at the present time the yield is rather small. The most important region was that near Diamantina, in the province of Minas Geraes. It is situated along the crest and on the flanks of the ridge that separates the San Francisco River and its branches from the Jequitinhonha and Doce Rivers. The diamonds are obtained in part from river washings and in part from prairie washings, as on the high ridge known as the heights of Curralinho. The river deposits consist of rolled quartz pebbles, mixed with or cemented by a ferruginous clay that usually rests on a bed of clay. The diamonds are most plentiful in large pot holes in the bedrock. In the upper plateau diggings the diamonds occur in part in a conglomerate, and some are reported from a quartzose schist in a region farther to the north.—*Mining Science.*

THE AMERICAN SYLLABUS IN ALGEBRA.

By E. E. Whitford,
College of the City of New York.

Mathematics played a subordinate part in the secondary school education of colonial days. Even as late as 1819, Harvard University, which had been the first collegiate institution to make any mathematical requirements for entrance, demanded only some slight familiarity with algebra from students wishing to matriculate there. It is not the present purpose, however, to trace the gradual increase in the college entrance requirements, or to note the amount and content of mathematics taught from year to year, but to seek what is being done to-day in algebra in the secondary schools of the United States.

The average minimum requirement for all high school pupils in mathematics is 2.84 years. This average is computed from the prescribed courses as issued by the state education departments of sixteen states. If this average is made from the reports of over sixty high schools where the elective system is in full force, the figures become 2.4 years. This latter estimate includes the Horace Mann High School and the high schools of Fall River, Mass., which require only one year of mathematics, although even there the ordinary high school pupil spends more time than this upon mathematics. Taking the official courses, both suggested and prescribed, as given out by the superintendents of public instruction of thirty-one states, the average pupil who completes the course in a four year high school studies mathematics 3.7 years. There are secondary schools, both in the East and in the West, not included in the above average, in which the pupil is required to put in five full years in mathematics in his four years' course. Of the 3.7 years above mentioned 1.8 years, or almost one half, is the average time devoted to algebra, as will be seen from the table. This is made up from returns from practically all of the states.

Several mathematical societies and associations have issued syllabi of algebra. The most elaborate of these and the one likely to be most helpful to the teacher is that of the Teachers of the Middle States and Maryland, adopted in December, 1909. Exceedingly interesting is the report of the Wisconsin State Teachers' Association on the content of algebra. Other valuable syllabi are issued by a committee of the American Mathematical Society, the College Entrance Examination Board and

the Missouri Society of Teachers of Mathematics. Several of the states and many cities issue syllabi, and nearly all the states which do not issue syllabi of algebra follow high school courses that are definitely marked out by state authority. This is indicated in the third column of the table, where "course" indicates prescribed or suggested state course, "syl" indicates a state syllabus and "Univ. req" indicates requirements of the state university.

In America, as in Europe, the principal divergence from the traditional course in algebra lies in the emphasis on graphic work and on the concept of variable and of function. All the syllabi lay stress on graphical methods. One says: "An important aim should be to acquaint the pupil with the notion of functionality, mainly through the early and continuous use of graphical methods," and "graphical methods should be employed wherever they are applicable." Weight is put on the large use of the idea of verification. "The verification of quadratic equations whose answers involve radicals should be used to give training in radical reductions. Such exercises have an advantage over the ordinary set ones because in them the student can judge for himself of the correctness of his operations, instead of depending upon an answer book, since if they have been correctly performed his final answer will be an identity; otherwise not." The syllabi make a loud clamor for practical problems, although one syllabus is willing to include among the practical those which are conceivable to the human mind. Some of them would omit the clock, hare and hound and cistern varieties, demanding in their place problems from geometry, physics, chemistry and commerce.

Many of the syllabi are very explicit as to "what to omit from the first year course if found in the text-book used." The syllabus of the State Teachers' Association of Wisconsin gives twenty-two paragraphs under this head. The general rule seems to be to omit complicated and difficult exercises, particularly the continued division process of H. C. F. and L. C. M., the cube root of polynomials, and difficult and impractical problems. The data that have been obtained in regard to omissions the first year together with the extent of the first year's course, as outlined by the fourth column, indicate a surprising degree of uniformity in the work throughout the country and a very conservative attitude toward changes in subject matter and order of topics. At the same time in several of the syllabi, particularly in the Middle

West, there are suggested modifications in the topic order. The Arkansas state syllabus says: It will be seen, therefore, that most of the different kinds of equations suitable for the first year may be taught before fractions, before factoring, before long division, even before multiplication of powers of like bases. This early introduction of simultaneous and quadratic equations increases vastly the scope and variety of problems that can be given." This explains why in the table against the state of Arkansas "through quadratics" is written in both the first year column and in the year and one half column, the latter being a review and filling out of the elementary course.

In order that the table may be presented in a more condensed and intelligible form, the following topics will be taken to comprise elementary algebra (abbreviated in the table as *el.*), fundamental operations, factoring including H. C. F. and L. C. M., fractions including complex fractions, ratio, proportion, simple equations both numerical and literal containing one or more unknown quantities, radicals, quadratic equations both numerical and literal, simple cases of equations with two or more unknown quantities that can be solved by methods of simple or quadratic equations, problems involving equations, binomial theorem for positive integral exponents. In the fourth column also "thru quad" is used to designate all of elementary algebra above described, except ratio and proportion. The symbol + indicates excess and — indicates lack.

Intermediate algebra (abbreviated as *int.*,) will be taken to comprise review, interpretation of the forms $\frac{a}{o}$, $\frac{a}{\infty}$, $\frac{o}{o}$, imaginaries, exponents, involution, evolution, theory of quadratic equations, arithmetic and geometric progressions, and graphical interpretation of equations. Advanced algebra will be taken to comprise review with more difficult applications, permutations, complex numbers, determinants, binomial theorem, undetermined coefficients, series, logarithms, detached coefficients, theory of equations, solution of higher numerical equations. This will be abbreviated in the table as *adv.* This abbreviated classification is intended to agree almost exactly with the syllabi of the committee of the American Mathematical Society, of the College Entrance Examination Board, and of New York, Missouri, Louisiana, and other states.

In the fifth column, the omissions the first year will be designated by letters explained as follows: a. Complicated brackets; b. H. C. F. and L. C. M. by division; c. Remainder theorem; d. Complicated complex fractions; e. Equations with more than three unknowns; f. Cube root of polynomials; g. Formal study of the theory of exponents; h. Extended study and manipulation of imaginaries; i. Equations containing complicated radicals; j. Theory of quadratics.

	Years	State Publication	Extent the First Year	Omissions the First Year	Extent in 1½ Years	Extent in Entire Course
Alabama	2	course	to quad	cij	int +	text completed
Arizona	1.5	course	thru simultan.	abcdefghij	thru quad	
Arkansas	2	syl	thru quad	abcdefghij	thru quad	int
California	2	Univ req	el	c		adv —
Colorado	2	course	thru quad			text completed
Connecticut	2		thru quad	ghij	int +	adv
Florida	2	course	to quad		int —	text completed
Idaho	1.5	course	thru quad	abij	int +	
Illinois	1.5	syl	thru quad	abcdefghij	int +	
Indiana	1.5	syl	thru quad	abcdefghij	int —	
Iowa	2 —		thru quad	abcdehi	int +	text completed
Kansas	2	syl	to quad	abdfij	int +	adv
Kentucky	1.5 +		to quad	abcfghij	int —	adv
Louisiana	1.5	syl	to quad	bhij	int +	
Maine	1.6	course	el	bcghij	int	
Maryland	1.5	course	to quad	b	int —	
Massachusetts	2		thru quad		int +	adv
Michigan	1.5	syl	to quad	abcd	int +	
Minnesota	1.5	Univ req	thru quad		int —	
Mississippi	2.5		to quad	cfghij		
Missouri	1.5	syl	el	bcdefghij	int	
Montana	2.5					
Nebraska	1.5	syl	to quad	f	int +	
Nevada	1.5		to quad	cdfghij	int —	
New Jersey	2.+	syl	to quad		int +	adv —
New Hampshire	2.+	course	to quad +		int +	adv +
New Mexico	2	Univ req	thru quad—	abcdefghij	int —	int + log
New York	2	syl	el	abcf	int +	adv
No. Carolina	2.5	course		bcdhij		text completed
No. Dakota	1.5	course	thru quad		int +	
Ohio	1.5		thru quad	bcdh	int +	
Oklahoma	2	course	thru quad		int +	text completed
Oregon	1.5+	course	to quad	bcdhij	int —	
Pennsylvania	2	syl	to simul. eq.	abcdefghij		int
So. Carolina	3	course				text completed
So. Dakota	1.5	course	to quad +	abij	int +	
Tennessee	2		to quad —	abcdefghij		thru quad +
Texas	1+		thru quad			
Utah	1.8	Univ req	thru quad	bcdhij	int —	int +
Vermont	1.5	course	el	bdefghij	int	
Virginia	2	course	thru quad	fghij	int —	int +
Washington	2	course	thru quad —	abcdehij	int +	text completed
West Virginia	1.5	course	to quad	abcfhj	int —	
Wisconsin	1.5	syl	thru quad	abcdefghij	int +	
Wyoming	2		to quad		int —	int + log

Where the work of all the high schools in a state, such as New Hampshire, has been examined, the minimum required is given in the table. Where a part of the schools in the state give an additional half year to algebra a plus sign has been placed in the second column. Some schools in Massachusetts and other states give a three year course in algebra. The topic most often added to intermediate algebra to round out the year and one half is logarithms.

As suggested at the outset, often the first year only is required and the second made optional, it being designed for students preparing for college or technical school and for those who have special aptitude for mathematics. The present tendency is to put this course in the third or fourth year of the high school.

Some states require or recommend a particular text, and the state syllabus is made up by directing what to take and what to omit and how to teach different chapters of that text. Kansas is a good example of this. Many state outlines or courses are concluded with the statement that such a text is completed.

Whatever of value this article may have is chiefly due to the heads of the education departments, and to other educators in the various states who have responded so courteously to requests for information.

The production in the United States in 1909 of tungsten concentrates reckoned at 60 per cent of tungstic trioxide was 1,958 short tons, valued at $746,130, according to figures from returns received from producers. These figures represent the exact production for the first eleven months of the year plus the estimated production in December. Of this amount Boulder County, Colo., produced 1,401 tons, valued at $550,280.—*U. S. Geol. Survey.*

A curious phenomenon was met with when some of the deep, long-abandoned workings of the Comstock mine became accessible. The hot, siliceous waters had partially silicified the timbers as the geysers of the Yellowstone have for ages been silicifying and turning into stone the trees in their vicinity. A beautiful example of the delicate fossilizing influence of the hot siliceous steam of this mine was shown by a specimen sent the writer of a piece of the impalpable, soft "fungus" common on decaying mining timbers, replaced by opaline silica down to the minutest fibre. This was taken from one of the partially silicified timbers.

THE ESSENTIALS OF BIOLOGY IN THE HIGH SCHOOL.

By A. H. Conrad,
Crane Technical High School, Chicago.

In the October number of School Science and Mathematics is an article entitled, "The Essentials of Biology in the High School," by Jean Dawson. It might appear to an onlooker as a stunning blow to biology in the high school, as a kind of final knockout to the methods in vogue among high school teachers of zoölogy and botany.

The article is all the more misleading from the fact that some of the statements made therein are true. For a truth may, if but half told and half withheld, give a false impression. The first charge made is that biology in the high school is undifferentiated from that in the college and the university, that the teacher entering the high school introduces what he has learned in the college with but few changes. This is saying more to the credit of such teachers in all probability than the writer intended. That teacher does well who strives to utilize what knowledge he has with such adaptive changes as he is able to make. His college course is all that he has in biology. He had no high school course, hitherto there was none. Biology has been obliged to work its way back into the high school from the university, and the high school teacher has not been materially aided by having his adaptive work planned by the university, nor even by the normal school. Biology has been and still is in its formative stage, precluding the idea of gradation or stratification to any great extent. It is probably the newest of the sciences which the writer had in mind; but this fact detracts nothing, since for sound pedagogical reasons—which it is unnecessary to introduce here—this formative stage of the science enhances its educational value and gives it a unique place in the curriculum.

As to the charge that the high school laboratory is often equipped with a compound microscope, oil immersion lens, microtomes, clinostat, etc., the present writer pleads guilty. He has all these and more in his laboratory, and he is pleased by the fact that he has facilities for investigating and verifying scientific problems, and that he is not forced by lack of facilities to die at the top. Nor does it do the pupil violence that he may get a glimpse of bacteria at some stage of his high school course, especially if his education is not to go beyond the high school. If the author inferred upon seeing this equipment in

the laboratory that it is placed in the hands of the elementary pupil to manipulate, as with university students, he should have remained long enough to verify his suspicions. But the author of the article failed to mention that in that same laboratory perhaps is a multitude of materials and preparations arranged to be placed in the hands of the individual pupils, including many series to illustrate economic products and processes, in both botany and zoölogy with the credit that they are the adaptive contribution of the high school teacher.

I fear that the author claimed too much when she asserted that "the high school text-books contain the most modern thought and theory that is advanced in our universities." It has too often been the experience of the present writer to find the text-book far behind the line of progress. Furthermore the text-books are for the most part prepared by university men who cheerfully assume the responsibility of handing the prescribed dose to the high schools, and that many of them are unsuited to the needs of the high school we frankly admit. This condition is made all the more permanent by the fact that the publishers of text-books are dominated by financial considerations; and the belief that a book will be the more salable if the name of the author be that of some university man who has achieved some prominence in his chosen field; and, as if to forestall competition, it seems that these publishers have combined to secure the passage of bills by some of our legislatures barring high school teachers from writing text-books, or, what amounts to the same thing, precluding the use of such books in the public schools. It might seem reasonable to believe that the high school teacher with broad training in the field of his chosen science, with a knowledge of the character and capabilities of high school pupils acquired through years of experience, would be a most capable person to prepare a text-book and that he should be barred from so doing by a state law is a case of rank class legislation. Again the teacher is not always responsible for the placing of the unsuited text in the hands of the pupil. It is often the result of an agreement between the agent of the publisher and the board of education or its agent. The biology teachers of a certain city appointed a committee of three teachers, presumably competent persons, to investigate and recommend the best suited, available text-book in a certain branch. The committee secured copies of practically all the texts on the subject published in the

United States from which five of the more promising ones were selected for minute inspection. The committee spent one session in considering and fixing upon certain features that in its judgment a text should have to recommend it to their use. At subsequent meetings these five texts were gone through part by part, chapter by chapter, paragraph by paragraph, and the individual judgments were tabulated with the final results that the books stood in the ratios of 115, 57, 52, 51, and 22. A detailed report of this work was made to the teachers and there followed a unanimous recommendation that the book taking first rank be adopted by the board of education. For some reason, best known to the publishers and the agent of the board, another book is in use, though three years have gone by.

The author's implication that it is usual for the high school teacher to devote a considerable time to the evolution of structure and of sex; laws of inheritance, including Lamarck's theory of acquired characters; and Mendalian laws, is unwarranted, and misleading to one unfamiliar with the facts. As to the candidate for a doctor's degree consulting a high school text-book preparatory to his examination it is neither strange nor reflecting upon the high school text. The candidate has been pursuing a special line of research to the neglect of general elementary principles. It is to the credit of each that he can find therein what may fit him for his examination.

The author, in order to "cinch" her allegation that the work of the high school is undifferentiated from that of the university, says, "I have visited a university, a college, a normal school, and a high school the same day, and found all four studying the *Amœba* in much the same way." This is certainly a *near miracle*, and we believe that what the author reported as seeing was the vision of a nightmare induced by the strenuous effort necessary to visit and inspect these four institutions in one school day, presumably of six hours.

She says, "This chaotic condition of affairs causes the general unrest and dissatisfaction which are felt and freely expressed at educational meetings, and are reëchoed by our journals of science." This statement is false in both logic and diction. In the first place the chaotic condition does not cause the unrest. The teacher recognizes the fact that the biological world is from time to time disturbed with new facts and new viewpoints and the true teacher is unresting in his efforts to relate himself and

adapt his work to his pupil's needs. And it is not *"dissatisfaction"* but *unsatisfaction.*

The author states that "in one high school the pupils were studying starch by the aid of the compound microscope," as though this were sufficient ground to condemn work of the teacher. We recall that but a few days since we had an elementary pupil who separated the starch from a potato with surprisingly accurate results and to add to his pleasure and profit he was allowed to examine the starch under the microscope that he might see more of the character of the starch and the purity of the product. Had the high school inspector chanced to look in at that particular moment he might have truthfully reported that our pupil was studying starch by aid of the compound microscope; but it would be one of those half truths that may be quite misleading.

As to what we may hear or not hear college instructors say as to the biological equipment of high school pupils may be of little moment. Words are cheap affairs and are often flippantly used.

The writer recalls a university professor who, in a laconic vein, referred to the high school frog as one without organs. When interrogated as to the significance of his remark he gave an explanation that was mutually satisfactory. We have seen this same professor receive some of these high school pupils for further instruction whose frogs were about as lively and could leap about as far as some propagated about the university campus.

The author of the article in question makes the opportunity to say that "as a proof that a reaction has set in against the present biological teaching is the fact that the biology of our high schools is not holding its own with her sister sciences, physics and chemistry. If the biology classes in the high school are not compulsory they are dwindling and are composed largely of girls." To which she adds in a subsequent sentence—"little girls with hair braided down their backs." This statement is so palpably erroneous that it calls for no reply further than to say that in the forty or fifty high schools with which the writer is familiar it is not true in any particular.

But this discussion is growing to some length and we will pass to the latter part of the author's article where she seems to have awakened from a Rip Van Winkle sleep and proceeds to tell us that the present biological teaching should be done away

with in the high schools and in its place substitute the study of insects, harmful and beneficial, with methods of destroying the former and protecting the latter; the study of birds, their habits and enemies, the work they do and our need of protecting them; the native fishes and their food; how bacteria multiply and disseminate diseases; how to guard against tuberculosis and other contagious diseases; to know the native trees of the locality and the conditions under which they thrive;—all of which and much more of like nature the more progressive high schools have been doing for the last ten years. And furthermore the present high school teachers of biology may be relied upon to carry on these adaptive changes to a happy consummation that shall be pleasing and helpful to all youth who shall so order their high school course as to include the study of biology, or the science of living things with whose destiny their own is so intricately woven.

HOW TO MAKE SOLDERING PASTE.

Soldering paste, says the *Brass World*, has now come into extensive use in electrical work as a flux for soldering. This has been brought about by the requirements of the electrical trade that in certain forms of soldering no acid shall be used. For soldering copper wires for electrical conductors, soldering paste is almost exclusively used. It has also entered other fields of soldering, particularly in instances where spattering and corrosion are objectionable.

Soldering paste, which is now used in the electrical trades, consists of a mixture of a grease and chloride of zinc. The grease which is commonly used is a petroleum residue, such as vaseline or petrolatum. Such material is about right in consistency. The proportions which are used are as follows:

Petrolatum ..... 1 lb.
Saturated solution chloride of zinc ..... 1 oz. (fluid)

The use of petrolatum instead of vaseline is recommended. While they are identical in composition, the name "vaseline" is registered as a trade mark and commands a higher price on this account. Petrolatum is much cheaper.

The chloride of zinc solution is made by dissolving as much zinc in strong muriatic acid as it will take up. An excess of zinc should be present and all the acid neutralized. This will form a thick, oily solution. The petrolatum and chloride of zinc are mixed and thoroughly incorporated by means of a mortar and pestle or by vigorous stirring.

The advantage of this soldering paste lies in the fact that it does not spatter and is not corrosive. It will be found excellent and is now extensively used.

REQUIREMENT OR RECOMMENDATION?

FRANKLIN T. JONES, UNIVERSITY SCHOOL, CLEVELAND, OHIO.

In the educational world great dissatisfaction with the results of instruction are evident. The scapegoat at present most popular is the college. It is about equally blamed for what it does do and for what it fails to do. Some seem to believe that the college is a poor excuse for anything and that is the very idea which it is intended to emphasize in this article.

English, they say, is not well taught, meaning, as nearly as one can discover, that the results are not nearly so good as might be desired. Boys and girls, as well as their elders, persist in misspelling simple words, using poor grammar and exhibiting faulty composition—faults that are not unique with the present generation. The college here proves a great convenience, because the teacher may excuse himself by saying that the college *requirements* are to blame without, however, explaining the exact reason why. Throughout the curriculum of the secondary school similar conditions with similar excuses are met.

There is so much laid to the college *requirement* that it might be interesting and instructive to find out the spirit and language in which it is expressed. Primarily because the College Entrance Examination Board is receiving its full share of criticism, let us examine its Document No. 25 which is taken up largely with "Definition of Requirements." Subject 1 is English. In order to exhibit the spirit of this requirement concerning books for reading, it is sufficient to quote the bold-face type only—"*In every case knowledge of the book will be regarded as less important than the ability to write good English.*" The candidate is informed that the examination will be conducted on certain definite subjects along specified lines. Results only are asked. The teacher and school are at liberty to proceed in any direction they choose. The Harvard requirement in English says concerning the study of the *prescribed* books: "He (the student) should read them as he reads other books; he is expected, not to know them minutely, but to have freshly in mind their most important parts." Concerning all subjects the Princeton catalog says, "It is recommended that candidates be prepared for examinations on the requirements as specified, but equivalents will be accepted." Case School of Applied Science frames its requirements in the following form: "It is recommended that the candidate's preparation in ..... should include: etc." The University of Michigan, which is a fair representative of the colleges admitting on certificate, says very briefly, "The one half unit in trigonometry should cover the work in plane trigonometry, as given in Crockett's 'Trigonometry,' or an equivalent in other authors." Similar statements are made for other subjects.

This all appears very fair to the teacher and seems to leave him free to adapt the *recommendations* of the college to the needs of his own school and class. Complaint has been made, however, supported by what must be excellent authority, that ogres in the form of high

school inspectors and examining officers invade this paradise and hamper the teacher so that "there is no subject which can be well taught in the high schools to-day for the simple reason that the colleges prevent it." [Woodhull in SCHOOL SCIENCE, 1910, page 38.] Such statements, so contrary to the experience of all who have actually come in contact with the college entrance problem, serve no useful purpose, but, on the contrary, form the basis on which teachers excuse poor work and unsatisfactory results on the ground that the "college requirements compel" them. It should be understood and practiced that these so-called *requirements are really recommendations only*, which give sufficient latitude for the accomplishment of about any kind of good work that the teacher may choose to carry on. They do and should check inefficiency, diffuseness, and aimlessness.

The new Requirement (so-called) in Physics of the College Board should be interpreted as a recommendation simply. Except that the notebook is no longer submitted to the examiner, it does not differ in spirit or in any essential particular from previous requirements or from the practice of the best teachers the country over. We who wish our pupils to take Board Examinations may expect about the same kind of questions as before. The pupil must know a little physics and be able to think clearly, express himself definitely on elementary topics, and apply some very elementary mathematics—not so much to expect, after all. If the youthful mind would only work at examination time with a slightly higher degree of accuracy, there would be little of which to complain.

Why should the per cent of failure on a list like the following be greater than 15%? Certainly not because we may not reasonably expect our average pupil to attain 60% on it in two hours' time.

BOARD PHYSICS, 1909.

Answer any two questions from this group:

1. A piece of metal introduced into a vessel full of liquid whose density is 0.8, sinks and displaces 20 gms. of the liquid. The same piece floats in mercury and displaces 65 gms. Find the weight, volume, and density of the piece of metal.

2. A man weighing 150 lbs. stands on one end of a railroad rail, 30 ft. long, which balances over a fulcrum at a point 2 ft. from its middle. What is the weight per yard of the rail?

3. A barometer tube has an inner cross-section of 1 sq. cm.; the top of the tube is 79 cm. above the surface of the mercury in the dish; two cubic centimeters of a gas, at existing atmospheric pressure, are admitted into the Torricelli vacuum, whereupon the mercury column stands at 64 cm. What is the existing barometric pressure?

Answer one question from this group:

4. Illustrate by diagram what is meant by overtones of a vibrating string. What is meant by musical intervals and by what factor are they fixed?

5. What must be the length of an open organ-pipe which is to give a note of 54 vibrations per second, the temperature being such that the velocity of sound in air is 1,100 feet per second? Will the pitch of

the note be raised, or will it be lowered, by rise of temperature?

Answer one question from this group:

6. Suppose heat is supplied at a uniform rate to a certain mass of ice at —10°C. until it is changed into steam at 110°C.: describe the physical changes which take place.

7. An iron rod is packed in melting ice, when its length is found to be 60 cm. It is then placed in freely escaping steam, the barometer at the time reading 76 cm. If the coefficient of linear expansion for iron is .000011, how long is the rod while in the steam?

Answer one question from this group:

8. Describe the human eye, considered as an optical instrument, using a diagram and naming the essential parts. Explain the adjustment of the eye for different distances.

9. The focal length of a convex lens is 15 cm. An object 2 cm. long is located 10 cm. from the lens. (*a*) Is the image real or imaginary? (*b*) How far is the image from the lens? (*c*) What is the size of the image?

Answer two questions from this group.

10. Eight cells are to be connected, 4 in series and 2 in multiple. (*a*) Draw a diagram showing how this is to be done and explain your diagram. (*b*) The cells as arranged in (*a*) are connected with an external resistance of 20 ohms. If the internal resistance of each cell is 2 ohms and the current through the circuit 0.25 ampere, what is the electromotive force of one cell?

11. Describe two instruments for measuring current-strength, one depending on the magnetic action of a current, the other depending on its chemical action.

12. Explain the operation of the electroscope, making the necessary diagrams.

MANIPULATION OF THE MICROSCOPE.

The proper manipulation of the microscope requires an adequate knowledge of the optical and mechanical principles underlying its construction. As an adjunct to their excellent treatise on the Manipulation of the Microscope by Edward Bausch, the Bausch & Lomb Optical Company has recently issued a very interesting and instructive chart of the Microscope Stand. Side by side are shown a perspective view and vertical cross-section of the most modern type of instrument. The different parts and accessories are clearly lettered and named and the path of the rays and the formation of the various images are very well shown. The chart, 3'9" by 4'7" in size is handsomely executed in colors and durably mounted on cloth, with rollers at the top and bottom. It is a very useful and attractive addition to the equipment of any laboratory and is now being distributed to the leading scientific institutions of the country.

PROBLEM DEPARTMENT.

E. L. BROWN.

Principal North Side High School, Denver, Colo.

Readers of the magazine are invited to send solutions of the problems in which they are interested. Problems and solutions will be duly credited to their authors. Address all communications to E. L. Brown, 3435 Alcott St., Denver, Colo.

Algebra.

178. *Proposed by H. C. Whitaker, Philadelphia, Pa.*

A and B who are 500 miles apart, travel toward each other, A going at the uniform rate of 20 miles per day; B goes 12 miles the first day, 11 miles the second day, 10 miles the third day, and so on. How far from B's starting place will they meet?

Solution by John P. Clark, Asbury Park, N. J.; John A. Hardin, Ft. Bliss, Texas.

The combined distances of A and B each day are 32, 31, 30 miles and so on forming an arithmetic series in which $s = 500$, $a = 32$, $d = -1$, and n is required. Solving, we get $n^2-65n+1000=0$, from which $n=25$ and $n=40$. Taking $n=25$ we find that in 25 days A travels at his 20 miles per day to B's starting place. In the meantime B has traveled for 12 days toward A making a distance of 78 miles. On the thirteenth day he rests, and during the remaining twelve days he retraces his steps to his starting point at which point A overtakes him. A forges ahead, but B by reason of his increasing rate in that direction is able to overtake A at the end of the fortieth day, at which time they are at a distance of 300 miles from B's starting point in the direction opposite to A's starting point.

179. *Selected.*

An agent gets 15% on note, and 20% and 10% on cash. Receiving goods listed at $300, he pays to the company $76.80 in cash; for how much must he give them his note on settlement?

I. Solution by W. G. Baab, Charles City, Iowa.

Let x = face of note.

Then $\frac{x}{100\% - 15\%}$ = amount paid by note.

The discounts of 20% and 10% are equivalent to a single discount of 28%.

$\frac{\$76.80}{100\% - 28\%}$ = amount paid in cash including discount,

$\therefore \frac{x}{.85} + \frac{76.80}{.72} = 300$

$\therefore x = \$164\frac{1}{3}$, face of note.

II. Solution by Orville Price, Denver, Colo.

The list price of $300 includes the face of the note, *commission* on note and on cash, and the amount of cash delivered on settlement. After the agent took his commission on cash there remained 72% of the cash receipts, but from this remainder he takes his commission on note, which is 15% of the face thereof, and pays the balance $76.80 into the hands of the company.

Let x = list price of goods sold for cash.
Then $300-x$ = list price of goods sold for note.
By conditions of problem

$$\frac{28x}{100}+\frac{15(300-x)}{100}+76.80=x$$

$\therefore$ $x=140$ and $300-x=160$.
Hence face of note is \$160.

The above solutions represent two views of this example. In the first, the agent buys the goods and is allowed a *discount*; in the second, he sells the goods and takes out a *commission*.

Geometry.

180. *Proposed by Philip Fitch, Denver, Colo.*

Points P, Q are taken on the sides BC, CA of the triangle ABC so that $BP=m'a$, $PC=na$, $CQ=rb$, $QA=sb$. AP and BQ intersect at O, CO and PQ in L, CO and AB in R; find (1) ratio of AR to RB, (2) ratio of QL to LP, (3) ratio of areas of OPCQ and ABC.

I. Solution by I. L. Winckler, Cleveland, O.

(1) Since QB cuts the sides of triangle ACP, $AO\cdot BP\cdot CQ=OP\cdot BC\cdot AQ$

$$\text{and } \frac{AO}{OP}=\frac{BC}{BP}\cdot\frac{AQ}{CQ}=\frac{a\,.\,sb}{ma\,.\,rb}=\frac{s}{mr}. \quad \ldots\ldots\ldots\ldots(1)$$

Also since QB cuts the sides of triangle APB, $AR\cdot BC\cdot OP=RB\cdot CP\cdot AO$

$$\text{and } \frac{AR}{RB}=\frac{CP}{BC}\cdot\frac{AO}{OP}=\frac{na}{a}\cdot\frac{s}{mr}=\frac{ns}{mr}.$$

(2) From triangle QPA and transversal OC, $QL\cdot AC\cdot OP=LP\cdot CQ\cdot AO$

$$\text{and } \frac{QL}{LP}=\frac{CQ}{AC}\cdot\frac{AO}{OP}=\frac{rb}{b}\cdot\frac{s}{mr}=\frac{s}{m}.$$

(3) Since triangles ACP and OAQ have angle CAP common

$$\frac{ACP}{OAQ}=\frac{AP\,.\,AC}{OA\,.\,AQ}=\frac{AP}{OA}\cdot\frac{AC}{AQ}. \quad \ldots\ldots\ldots\ldots(2)$$

From (1) by composition, $\frac{AP}{OA}=\frac{mr+s}{s}$.

$\therefore$ (2) becomes $\frac{ACP}{OAQ}=\frac{mr+s}{s}\cdot\frac{b}{sb}=\frac{mr+s}{s^2}$.

$$\therefore \frac{ACP-OAQ}{ACP}=\frac{mr+s-s^2}{mr+s}$$

$$\text{or } \frac{OPCQ}{ACP}=\frac{mr+s-s^2}{mr+s} \quad \ldots\ldots\ldots\ldots(3)$$

$$\text{also } \frac{ACP}{ABC}=\frac{na}{a}=n \quad \ldots\ldots\ldots\ldots(4)$$

$\therefore$ From (3) and (4) $\frac{OPCQ}{ABC}=\frac{(mr+s-s^2)\cdot n}{mr+s}$.

II. Solution by the Editor.

Let triangle $ABC=\triangle$, $OPC=N$; $OCQ=M$; then $OQA=\frac{s}{r}M$, $OPB=\frac{m}{n}N$.

$m+n=r+s=1$.

$$\frac{M+N+\frac{m}{n}N}{\triangle}=\frac{r}{r+s}=r. \quad \ldots\ldots\ldots(1)$$

$$\frac{M+N+\frac{s}{r}M}{\triangle}=\frac{n}{m+n}=n. \quad \ldots\ldots\ldots(2)$$

From (1) and (2) we easily get

$$\frac{M}{\triangle}=\frac{nr(r-1)}{nr-1} \quad \ldots\ldots(3), \text{ and } \frac{N}{\triangle}=\frac{nr(n-1)}{nr-1}. \quad \ldots\ldots\ldots\ldots(4)$$

From (3) and (4) $\frac{M}{N}=\frac{r-1}{n-1}=\frac{s}{m}$ $\ldots\ldots\ldots\ldots(5)$

$$\text{Now } \frac{AR}{RB}=\frac{AOC}{BOC}=\frac{M+\frac{s}{r}M}{N+\frac{m}{n}N}=\frac{M}{N}\cdot\frac{n}{r}=\frac{s}{m}\cdot\frac{n}{r}=\frac{ns}{mr}.$$

$$\text{Again, } \frac{QL}{LP}=\frac{QOC}{POC}=\frac{M}{N}=\frac{s}{m}.$$

From (3) and (4) $\frac{M+N=OQCP}{\triangle}=\frac{nr(n-1)+nr(r-1)}{nr-1}$

$$=\frac{nr(m+s)}{mr+s}.$$

Since $m+n=r+s=1$, obviously $\frac{(mr+s-s^2).n}{mr+s}=\frac{nr(m+s)}{mr+s}$; also $mr+s=m+ns$.

181. *Proposed by W. T. Brewer, Quincy, Ill.*

The entire surface of a right cone whose slant height is 17, is equal to the surface of a certain sphere; but the volume of the sphere is twice that of the cone. Required radii of the cone and of the sphere.

Solution by H. G. McCann, Kent's Hill, Me.; Walter L. Brown, Albion, N. Y.

Let R and r be the radii of the cone and the sphere. By conditions of problem we have

$4\pi r^2=17\pi R+\pi R^2$,

and $\frac{2}{3}\pi r^3=\frac{1}{3}\pi R^2\sqrt{17^2-R^2}$.

Whence $R^3(17+R)^5=16R^4(17+R)(17-R)$.

Therefore $R^3=0$, $17+R=0$, and $(17+R)^2=16R(17-R)$.

Hence $R=7\pm4\sqrt{2}=1.343$ or 12.657; also $R=0$ or -17.

Similarly $r=\sqrt{50\pm31\sqrt{2}}=2.481$ or 9.687; also $r=0$ or 0.

Remark by H. E. Trefethen.

This problem illustrates the comprehensive nature of algebraic language. The negative and zero results belong to the limiting cases of the cone and sphere. The -17 indicates that the area of the base is to be *subtracted* from the area of the circle which in this limiting case represents the lateral surface of the cone.

Applied Mathematics.

182. *Proposed by H. E. Trefethen, Kent's Hill, Me.*

Determine the center of gravity of a hemisphere by geometrical demonstration.

Solution by the Proposer.

We assume that the center of gravity of a pyramid is in the line joining the vertex with the center of gravity of the base at ¾ the distance from the vertex, as proved geometrically in Goodeve's Prin. of Mech., p. 147 and other texts.

Let O be the center of the given hemisphere and R = its radius. Conceive the hemisphere to be made up of small spherical pyramids with their vertices at O and let O—*abc* be one of these. Also let A, B, C be points in O*a*, O*b*, O*c* produced cut by a plane tangent to the sphere and parallel to the plane *abc*. Denote the plane pyramid O—*abc* by *p*, the spherical pyramid O—*abc* by *p'*, the pyramid O—ABC by P, their centers of gravity by *g*, *g'*, G and the centroids of the triangles *abc*, ABC by *h* and H.

Since the three pyramids lie in the same triedral angle and in volume $p<p'<P$, it follows that $Og<Og'<OG$. If now the edges of the pyramids be brought continually nearer together, these inequalities remain true, O*h* and OH approach R as their limit, and O*g*, O*g'*, OG all approach the same limit 3R/4.

Hence we may consider the locus of the centers of gravity of the spherical pyramids to be the surface of a hemisphere with center at O and radius = 3R/4 as the limit approached when their number is increased indefinitely. Moreover, since the masses of these pyramids are proportional to their bases, which in turn are proportional to the areas intercepted on the smaller sphere by the pyramids, the center of gravity of the given hemisphere would be in no way changed if its total weight were collected in the surface, or thin *uniform* shell, of this smaller hemisphere.

Again since on a sphere zones of equal altitudes have equal areas, the center of gravity of this shell bisects the radius which is perpendicular to its base. This point is the center of gravity of the given hemisphere and its distance from O = ½ of ¾ of R = 3R/8.

Miscellaneous.

183. *Proposed by H. C. Whitaker, Philadelphia, Pa.*

A conical wine glass, six inches deep and six inches in diameter, is full of wine. When turned 30° to one side, how much wine runs out?

Solution by G. B. M. Zerr, Philadelphia, Pa.

Let A be the highest point, B the lowest, on the rim of the glass, C the vertex, CD the altitude, BE the major axis of the elliptic surface of wine when tipped 30° from the vertical, EF parallel to AB, GH parallel to AB through the center O of the elliptic surface, CP a perpendicular to BE meeting BE produced in P. Let *b* be the semiminor axis, and *a* the semimajor axis.

CD=6, BD=DA=3, CA=CB=$3\sqrt{5}$.

Let the semi-vertical angle of ACD = α.

Angle ABE = $\beta = 30°$. $\sin\alpha = 1/\sqrt{5}$, $\cos\alpha = 2/\sqrt{5}$.

$b^2 = HO \cdot OG = \frac{1}{2}\,AB \cdot \frac{1}{2}\,EF = \frac{1}{4}\,AB \cdot EF$.

$$BE = \frac{AB\cos\alpha}{\cos(\beta-\alpha)} = \frac{24}{2\sqrt{3}+1} = \frac{24}{11}(2\sqrt{3}-1) = 2a.$$

$$\frac{EF}{AB} = \frac{CE}{CA} = \frac{CE}{CB} = \frac{\sin EBC}{\sin BEC} = \frac{\cos(\beta+\alpha)}{\cos(\beta-\alpha)}$$

$$\therefore EF = \frac{AB \cos(\beta + \alpha)}{\cos(\beta - \alpha)} = \frac{6(2\sqrt{3} - 1)}{2\sqrt{3} + 1} = \frac{6}{11}(2\sqrt{3} - 1)^2.$$

$$CP = CB \cos(\beta + \alpha) = \frac{3}{2}(2\sqrt{3} - 1).$$

$$\therefore a = \frac{12}{11}(2\sqrt{3} - 1), \text{ and } b = \frac{3(2\sqrt{3} - 1)}{\sqrt{11}}.$$

Volume of cone ABC $= 18\pi$.

$$\text{Volume of cone CEB} = \frac{\pi \cdot a \cdot b \cdot CP}{3} = \frac{36\pi}{22\sqrt{11}}(2\sqrt{3} - 1)^3$$

$$\text{Wine running out} = 18\pi\left[1 - \frac{1}{11\sqrt{11}}(2\sqrt{3} - 1)^3\right] = 33.356 \text{ cu. in.}$$

CREDIT FOR SOLUTIONS RECEIVED.

Algebra 172. Walter L. Brown, John A. Hardin. (2)

Applied Mathematics 177. Walter L. Brown, J. H. Weaver. (2)

Algebra 178. W. G. Baab, T. M. Blakslee (3 solutions), W. B. Borgers, W. T. Brewer (2 solutions), Walter L. Brown, Perry A. Carpenter, John P. Clark, Edward R. Gross, John A. Hardin, Eloise A. Harrison, I. E. Kline, H. L. McAlister, H. G. McCann, Orville Price, E. S. Riley, I. L. Winckler, G. B. M. Zerr. (20)

Algebra 179. W. G. Baab, Wm. B. Borgers, Walter L. Brown, John P. Clark, H. G. McCann, Orville Price (2 solutions), G. B. M. Zerr. (8)

Geometry 180. Walter L. Brown, Orville Price, H. E. Trefethen, I. L. Winckler, G. B. M. Zerr. (5)

Geometry 181. W. G. Baab, T. M. Blakslee, W. B. Borgers, W. T. Brewer, Perry A. Carpenter, John A. Hardin, I. E. Kline, H. L. McAlister, H. G. McCann, Orville Price, H. E. Trefethen, W. H. Weslar, I. L. Winckler, G. B. M. Zerr. (14)

Applied Mathematics 182. Walter L. Brown, H. E. Trefethen, G. B. M. Zerr. (3)

Miscellaneous 183. W. G. Baab, T. M. Blakslee, Wm. B. Borgers, H. E. Trefethen, I. L. Winckler, G. B. M. Zerr. One incorrect solution. (7)

Total number of solutions, 61.

PROBLEMS FOR SOLUTION.

Algebra.

190. *Proposed by Walter L. Brown, Albion, N. Y.*

Prove that no four square numbers can be in arithmetical progression.

191. *Selected.*

If $$u_1 = \frac{Mu + M'u'}{M + M'} - \frac{eM'}{M + M'}(u - u'), \ldots\ldots (1)$$

and $$u'_1 = \frac{Mu + M'u'}{M + M'} + \frac{eM}{M + M'}(u - u'), \ldots\ldots (2)$$

prove $$Mu_1^2 + M'u_1'^2 = Mu^2 + M'u'^2 - \frac{(1 - e^2)MM'}{M + M'}(u - u')^2. \ldots\ldots (3)$$

Geometry.

192. *Proposed by W. G. Baab, Charles City, Iowa.*

Within a circle whose diameter is 50 there are inscribed three equal circles, each of the four circles being tangent to the other three. Find (a) the radius of the inscribed circles, and (b) the area of the large circle not included by the small circles.

193. *Proposed by Charles T. Moore, Columbus, Ohio.*

If a be an edge of a regular icosahedron, V its volume, r the radius of inscribed sphere, and R the radius of circumscribed sphere, show by elementary geometry:

(1) $r = a\sqrt{\dfrac{7+3\sqrt{5}}{24}}$,

(2) $R = a\sqrt{\dfrac{5+\sqrt{5}}{8}}$,

(3) $V = \dfrac{5a^3}{12}(3+\sqrt{5})$.

Applied Mathematics.

194. *Proposed by Wm. B. Borgers, Grand Rapids, Mich.*

What function of t is θ when $\dfrac{d\theta}{dt} = a^4 - \theta^4$?

This formula is an expression of Stefan's law that the rate at which a body loses heat is proportional to the fourth power of its absolute temperature. Let θ = the absolute temperature of a body, a = absolute temperature of the surrounding medium, and t = time. Then, choosing such units as will eliminate proportionality factors, the rate at which the temperature of the body falls is $\dfrac{d\theta}{dt} = a^4 - \theta^4$.

Red stars are more numerous than they are generally believed to be, but since they are generally small in magnitude, everyone is not able to see them; that is a privilege reserved for astronomers, who are fortunate possessors of powerful instruments. Some regions of the sky seem to be specially favorable for this purpose. At the observatory of Arequipa there has been discovered one of these regions, where there is found a remarkable group of 29 of these stars, all of which are more brilliant than the tenth magnitude; four of them are double stars. The region of the sky where this discovery has been made is on the border of the Milky Way, and in the constellation of the Scorpion. It is limited in right ascension by 18 h. 48 m. and 19 h. 29 m., and in declination by —13 deg. and —23 deg.

REAL APPLIED PROBLEMS IN ALGEBRA AND GEOMETRY.

COMMITTEE ON INVESTIGATION: JAMES F. MILLIS, *Chairman, Francis W. Parker School, Chicago;* JOS. V. COLLINS, *State Normal School, Stevens Point, Wis.;* C. I. PALMER, *Armour Institute of Technology, Chicago;* E. FISKE ALLEN, *Teachers College, New York, N. Y.;* A. A. DODD, *Manual Training High School, Kansas City, Mo.*

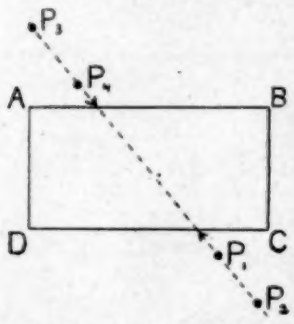
Teachers of mathematics who are interested in the movement to reform the teaching of mathematics in secondary schools by teaching the subjects more in relation to their practical uses are earnestly requested to coöperate with this committee *(1) by contributing real applied problems in algebra and geometry to be printed in these columns, where they will be accessible to all teachers for class room use, and (2) by using the problem material here printed in the class room with a view to determining its adaptability to the interests and needs of secondary school pupils.*

For the convenience of teachers who wish to use them, the problems printed in SCHOOL SCIENCE AND MATHEMATICS up to November, 1909, have been rearranged and grouped according to the topics of algebra or the books of geometry under which they come, and bound into a pamphlet, so that a copy may be placed into the hands of each pupil. These pamphlets may be secured from the Secretary of the Mathematics Section, Miss Mabel Sykes, South Chicago High School, Chicago, Ill., in any quantity, at 5c. a copy.

PROBLEMS.

By A. A. Dodd, M. T. H. S., Kansas City, Mo.

1. A contractor wishes to place a small sewer pipe underneath building ABCD, so that it will be in line with pegs P_1 and P_2. It is desired to place a man on each side of the building to dig the trench. If the contractor has a tape line and a sextant (instrument for measuring angles), show how he can set pegs P_3 and P_4 so as to be in line with P_1 and P_2, and thereby have the two parts of the trench meet.



By Jos. V. Collins, State Normal School, Stevens Point, Wis.

2. A farmer has a team, one horse of which weighs 1,200 lbs. and the other 1,400 lbs. If draft power is proportional to weight, where shall he put the clevis on his 50-inch doubletree?

3. A man has three horses, weighing 1,600 lbs., 1,500 lbs., and 1,200 lbs. respectively, hitched to a three-horse doubletree, the heavy horses on the two-horse doubletree. Assuming that draft power is proportional to weight, how shall he place the clevises so that each horse shall have a square deal, if the trees are 4 ft. and 6½ ft., respectively, in length?

4. A farmer wishes to build 120 rods of wire fence with 91 posts that he has available. One-sixth is over hilly ground, one-third over less hilly ground, and the remainder on the level. If he puts his posts 2 ft. closer on the hillier ground, and twice as far apart on the level, as on the less hilly ground, how far apart shall he put them? Prove answer. (Suggestion: Do not count one of the end posts.)

5. A man left to his three sons a farm worth $9,300. The older son got $700 toward his education, the second $300, and the third $200. The father wanted these inequalities corrected by the corresponding sums in the final settlement. How much did each son get?

6. A man wished to divide his barn space into five parts: a horse stable, an entry to the horse stable, two cow stables, and one entry to the two cow stables. The horse stable was to be at one end, and the cow entry between the two cow stables. He wanted the cow entry 1 ft. narrower than the horse entry, and the cow stables 2½ ft. narrower than the horse stable. Also the horse stable entry width was to be 2/5 of the width of the horse stable. His barn was to be 53 ft. long. How wide was each stable and entry?

By C. I. Palmer, Armour Institute of Technology, Chicago.

7. A chemist has a flask, containing V cc of a mixture of an insoluble solid combined with a solution of another substance. To determine the weight of the substance in solution, S *cc* of the solution are drawn off and the weight of the substance in this determined. S *cc* of water are then added to the flask, and another S *cc* of the weaker solution drawn off, and the weight of the substance in this determined. Show that the weight of the substance in the original solution in flask is $\frac{a^2}{a-b}$ where a and b are the weights of the substance in the first and second S *cc* drawn off, respectively.

(While the above is perhaps not too difficult for a high school pupil, it is only very recently that the method has been used by chemists.)

8. If an indebtedness of $1,800 is paid at $5.00 per week, each payment to cover the accrued interest to that time, how many payments will be required? Interest to be 5% per annum, counting 52 weeks per year.

(A banker was found trying to find the number of payments in the above by finding the amount of $1,800 for one week at 5%, and then subtracting $5.00. The remainder was then used as a new principal and the operation repeated. He said that it would take him about two days to find the number of payments.)

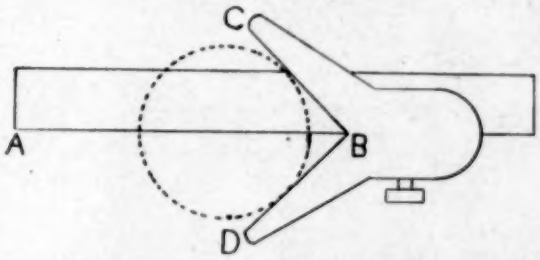
In the above, if p = principal, b = weekly payment, r = rate per week, and n = number of payments, show that the value of n is given by the following formula: $n = \frac{\log b - \log(b - pr)}{\log(b - r)}$.

9. Justify the following approximate construction for determining the circumference of a circle when the diameter is given, and show that the error is about 1 in 13,000,000: Draw two perpendicular lines, AB and AC. On AB lay off AD=7 1/16 inches, and on AC lay off AE=22 3/16 inches. Draw DE. Also on AB lay off AF=diameter given, and draw line through F parallel to DE, intersecting AC in G. Then the length AG is the circumference.

Modify this construction so as to find the diameter when the circumference is given. In each case apply the carpenter's square. (This is using the famous ratio of diameter to circumference 113/355, discovered by Peter Metius.)

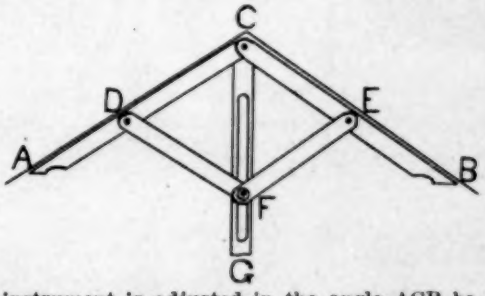
By James F. Millis, Francis W. Parker School, Chicago.

10. The figure is the drawing of a "Center Square," an instrument used for locating the centers of circular objects. The piece of metal with two arms BC and BD forming a right angle is attached to the straight edge AB so that AB bisects the angle CBD. Show that if the instrument is placed so that the arms BC and BD are tangent to a circular object, the straight edge AB will pass through the center.

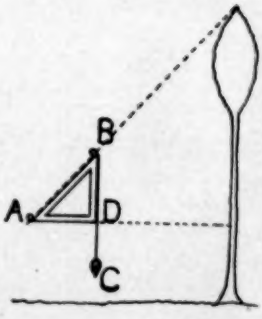


In case the circular object is so large, as often is the case, that the arms BC and BD are not tangent to it, but rest against it at the points D and C so that BC and BD prolonged would become secants, show that AB will pass through the center.

11. This figure is the drawing of an "Angle Divider," an instrument used by carpenters and others in fitting moldings and in other wood work. It consists of two arms, AC and BC, working on a pivot at C, a third piece CG containing a slot as shown, and two equal pieces, DF and EF, pivoted at D and E and fastened by a set screw F which works in the slot of CG. DC = EC.

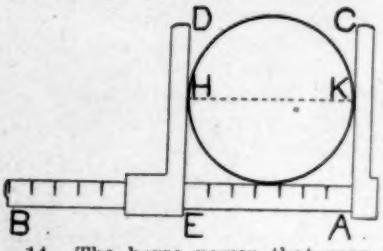


In fitting moldings, the instrument is adjusted in the angle ACB between two walls, and the set screw F fastened. Show that CG bisects the angle ACB, and hence gives the half-angle at which each piece of molding must be cut.



12. The figure shows a method in practical use in forestry of finding the height of a tree by use of an isosceles right triangle with two sights A and B and a plumb line BC attached. Show that if the instrument is held so that the plumb line coincides with the side BD of the triangle, the side AD is horizontal. Show by similar triangles that the height of the tree is equal to the dis-

tance from the observer to the tree plus the height of the observer.



13. This figure shows one of the large calipers used in forestry for measuring the diameters of trees. Show that the diameter HK of the tree equals the distance EA read on the scale BA. The arms CA and DE are both perpendicular to the graduated rule BA.

14. The horse power that may be safely transmitted by a certain kind of shafting without twisting or breaking it is computed by the formula $\text{H. P.} = \frac{nd^3}{64}$, where n = number of revolutions per minute, and d = diameter of shafting in inches.

How many horse power can be transmitted by such a shafting of 4-in. diameter, making 76 revolutions per minute? One of 5-in. diameter, making 100 revolutions per minute?

15. The velocity of the recoil of guns is computed by the formula $V = \frac{wv}{W}$, where V = velocity of recoil, W = weight of gun and carriage, in pounds, w = weight of projectile, v = muzzle velocity of projectile.

A 10-inch gun on a battleship fires a 400-lb. projectile with a muzzle velocity of 1,400 ft. per second. Weight of gun and carriage = 22 tons. Find velocity of recoil.

16. The force or pressure P of the wind against a surface, in pounds per square foot, is computed from $P = 0.005V^2$, where V = velocity of wind in miles per hour. Find the force of wind when blowing at 60 miles per hour. What would be the total force exerted by this wind against the side of a house 180 ft. long and 40 ft. high?

17. When a brick arch is supported by a tie-rod to keep the walls from spreading, the stretching force exerted on the rod, or "horizontal thrust," in pounds per lineal foot of arch, is obtained by the formula $F = \frac{1.5WS^2}{R}$, where W = weight on arch in pounds per square foot, S = span of arch in feet, R = rise of arch in inches.

Find the strain on the tie-rod in an arch on which the weight is 360 lbs. per sq. ft., the span 4 ft., and rise of arch 18 inches.

18. If a beam L ft. long, such as a beam holding the floor of the school room, is supported at both ends and loaded uniformly throughout its length with W lbs. per foot, the greatest bend or deflection D at the middle, in inches, is obtained by the formula $D = \frac{5WL}{384EI}$. This formula is used by architects in designing buildings for different uses.

If a beam in which E = 30,000,000 and I = $\frac{5}{8}$ is 12 ft. long, and the load 200 lbs. per foot, find the deflection.

PROPOSED CHANGES IN POSTAL RATES.

The following editorial from the *Review of Reviews* for January, 1910, expresses the views of the Editor of this journal so well that the article is reprinted here.

A recommendation that shows lack of full study advises the increase of postal rates on newspapers, magazines, and periodicals. For a long time second-class matter has been carried at 1 cent a pound. If this is less than it costs the Government to transport and distribute newspapers and periodicals, it does not necessarily follow that the rate ought to be raised. Within the memory of middle-aged persons postage on newspapers and periodicals was paid by the subscribers at their local post-offices. The change of law requiring advance payment at pound rates by the publishers shifted the burden from the subscribers and was a convenient reform. It is true that printed matter constitutes the large part of the mail carried by the Government. But the periodicals do more to nationalize literature and public opinion than any other one thing. Furthermore, very much of the profitable business of the Post-Office Department grows directly out of the publicity created by newspapers and magazines. Even the direct transactions with the post-office of a publisher are profitable to the Government, inasmuch as the purchases of postage stamps for the carrying on of correspondence with subscribers, and the other postal business of such an establishment, give the Government far more profit than its handling of the magazines at the rate of 1 cent a pound can cause it loss.

Mr. Taft is of opinion that the magazines carry more advertising in proportion to reading matter than the newspapers. This, as it happens, is an entire mistake. But the suggestion gives opportunity to explain that of all the business done by the Post-Office Department the most profitable is the carrying of advertising. Rather than force magazine advertising out of the mails, the Government could better afford to carry it for nothing. The chief object of the reputable business people who patronize the advertising pages of the periodicals is to provoke correspondence. A single advertisement on one page of a periodical has brought to the advertiser seventeen thousand letters. Each one of these letters starts a return patronage of the mails. The actual carrying of that advertisement has cost the Government an infinitesimal sum. The return received by the Government has been the large profit upon the sale of many thousands of 2-cent stamps. It is impossible properly to consider the rate of postage to be charged by the Government on one class of matter without studying the relation of the rates on different classes to one another. Mr. Taft is actuated by a commendable desire to lighten the burdens of the Government and to introduce economies. But as a matter of fact the carrying of newspapers and periodicals is not a burden to the Post-Office Department, and it is a great boon to the intelligent public of America.

It should be borne in mind that what he calls the deficit in the Post-Office Department is not real. The Post-Office Department is earning a large surplus profit on the business it carries on for its

patrons. Even if all publishers and private individuals and firms withdrew their business from the Post-Office Department, the Government would still have its own large distribution of letters and printed material to make for Congress, for the Departments at Washington, and for the official business of several hundred thousand people constituting the civil and military services of the United States. It would probably have to pay from seventy-five to a hundred million dollars a year to carry on its own postal business. Yet the books of the Post-Office Department do not make any account whatsoever of this vast item. It is safe to say that there is no other government in the world whose postal department is not credited with the expense it incurs for handling the business of the other departments. It is a scandal and a public disgrace that business should be done so loosely at Washington that no post-office records are allowed to show what it actually costs to distribute the speeches of congressmen, the documents sent out from the Agricultural and other departments, and the millions of letters relating to Government business. It is just as much a matter of Government expense to transport official documents as to transport troops. The War Department makes record of the cost of transporting troops, but no reports of the Post-Office Department indicate the cost of carrying the Government's own materials.

Furthermore, the enormous extension of free rural delivery has added a burden of many millions of dollars to the Post-Office Department without bringing immediate financial returns. Congress ought to have made some direct appropriation for this service. Even if the free rural carriers could be permitted to deliver small parcels for the benefit of the people on their routes, this valuable extension of the service could soon be made almost self-supporting. It is not uninteresting to note the fact that certain express companies and other private interests are always lobbying at Washington to prevent the passage of such measures as a parcel post for the convenience of the people. And the public may just as well be informed of the fact that these same interests have been busily at work for some years trying to secure an advance in the postal rates on periodicals and newspapers. It only needs statement to make it clear that if magazines and newspapers were thrown out of the mails by prohibitive postal rates certain news companies and express companies might hope to play a larger part in the distribution of such periodicals. The subject is one that Mr. Taft has not taken up as yet at first hand, and in the multiplicity of great topics that have been crowding upon his attention in the opening weeks of his term, it is, perhaps, not strange that he should have been misled in a few matters.

There is more need in the Post-Office Department of a careful reorganization than in any other branch of the Government. Mr. Taft's idea of driving a wedge between the newspapers and the periodicals of more general circulation seems wrong in principle and is based upon a misunderstanding of the facts. Free delivery within the county is already a great discrimination in favor of newspapers. Furthermore, the cost of handling each individual piece is a more important item than the cost of transportation by the pound. Thus

it costs the Government a great deal more to handle a pound of newspapers, consisting of a number of separate papers to be distributed to different people, than to carry a single magazine weighing a pound to one subscriber. Yet Mr. Taft, through misapprehension, states the matter in exactly the opposite way. The magazines are chief producers of the lucrative business of the post-office. Even without revision of the very favorable contracts with the railroads for carrying the mail, and without the other economies that could be brought about by a better business organization of the postal service, there is so large a profit collected by the Government upon all the business that the post-office does for private patrons, including the newspapers and periodicals, that this surplus practically pays the Government's own great bill for carrying and distributing its own mail matter.

FORESTRY INFORMATION.

Teachers throughout the country have been invited by the United States Forester to coöperate with the Forest Service in an effort to obtain more definite knowledge of the characteristics of the most important forest trees of the United States. To do this it will be necessary to obtain a large number of volunteer observers who will collect material on the time of leafing, blossoming, and fruiting of the various kinds of forest trees. In his letter inviting the coöperation of the teachers, Forester Pinchot says:

"Knowledge of this kind is greatly needed and will be of value from the standpoint both of education and of practical forestry. For educational purposes the results obtained for each species, averaged and presented graphically by means of colored charts, will be available to all who are interested in the subject, and particularly to schools. They will form virtual 'tree calendars,' and will be valuable aids to nature study.

"Children can readily be interested in the actual work of obtaining records. This should form an attractive outdoor feature of the school work that should serve to develop the faculty of accurate observation, and at the same time to promote an interest in forestry which may lead to a better appreciation of its aims and methods. It may also prove to be a profitable addition to botany courses for older students.

"A study of this kind will be of great value to practical forestry, since the proper treatment of forests depends partly upon a knowledge of these characteristics of trees. For example, the time of year at which a tree leafs out and blossoms is one of the indications as to whether or not it is frost-hardy in a given region, and the length of time that a tree is in leaf influences the growth it is able to make during the season. Knowledge of the time when seeds of each species ripen in various localities is of great value to those who are collecting seed, since seed often deteriorates or is eaten by squirrels and birds if not gathered and stored as soon as ripe.

"Another result of this study will be a more intimate knowledge of climate as manifested by plant growth, for differences in climate are shown by plant life as well as by instruments, and a preliminary idea can thus be gained as to whether a given region is suited to a valuable tree which it is desired to introduce there. Many such examples could be given, but sufficient has been said to show that the results of these observations will be a real help to practical forestry, in addition to their general interest and educational value. Volunteers will later be supplied with publications and charts containing the information they help to gather, as a return for the services rendered."

On request, the Forest Service will be glad to send forms upon which to record data and a pamphlet containing full instructions as to the nature of the observations and how they are to be made.

GROWTH OF GAS-PRODUCER POWER PLANTS.

More than 500 producer-gas power plants, ranging in size from 15 to 6,000 horsepower, are now in operation in the United States. About 88 per cent of these plants are running on anthracite coal, a few on anthracite coke, and the remainder on bituminous coal and lignite. In a bulletin on the recent development of the gas-producer power plant in the United States (Bulletin 416), just issued by the United States Geological Survey, R. H. Fernald, consulting engineer, states that the internal-combustion engine has already become a serious rival of the steam engine in many of its applications, and that the development of the large gas engine within the last few years has been extremely rapid. Only nine years ago a 600-horsepower engine exhibited at the Paris Exposition was regarded as a wonder, but to-day four-cycle, twin-tandem, double-acting engines of 2,000 to 3,500 horsepower can be found in nearly all well-equipped steel plants, and some plants in this country contain several units rated at 5,400 horsepower each.

This rapid advancement of the large gas engine was made possible by improvements in the production of cheap gas directly from fuel by means of the gas producer. A few scattered producer-gas plants were installed for power production in the United States before 1900, but the application of engines of this type to the production of power in any general sense has been developed since that date. During the first few years of this period of development anthracite coal, coke, and charcoal were used almost exclusively. It remained for the United States Geological Survey, in its testing plants at St. Louis and Norfolk, to demonstrate the possibility of using in such plants practically all grades of fuel of any commercial value, without reference to the amount of sulphur or tarry matter they contain.—*U. S. Geol. Survey.*

ARTICLES IN CURRENT MAGAZINES.

American Forestry for January: "Perpetuating the Timber Resources of the South," by R. S. Kellogg; "The Forests of Louisiana," by Frederick J. Grace; "The Crisis in the Southern Forests," by Henry E. Hardtner; "The Commercial Possibilities of Shallow Streams," by John L. Mathews.

Astrophysical Journal for December: "The Resonance and Magnetic Rotation Spectra of Sodium Vapor Photographed with the Concave Grating," R. W. Wood and Felix E. Hackett; "Two Curiously Similar Spectroscopic Binaries," J. S. Plaskett and W. E. Harper; "The Effect of a Magnetic Field Upon the Absorption Spectra of Certain Rare Earths," W. F. Schulz.

Auk, The for January: "Additional Notes on the Birds of Labrador," C. W. Townsend and A. C. Bent; "One Hundred Breeding Birds on an Illinois Ten-Mile Radius," Isaac E. Hess; "The Palm-Leaf Oriole," Florence M. Bailey; "Some Winter Birds of the Season 1908-09 in Wayne County, Michigan," J. C. Wood; "Audubon's Labrador Trip of 1833," Ruthven Deane; "A Winter of Rare Birds at Ottawa, Ontario," G. Eifrig.

Bird-Lore for November-December: "A Day With the Birds on a Guiana Savanna," C. W. Beebe; "Notes on Alberta Grebes," John M. Schreck; "A Heath Hen Quest," Katharine B. Lippetts; "A Ruffed Grouse's Lodging," R. S. Eustis; "The Ways of Bob-White," Frances M. A. Roe; "The Migration of Sparrows," W. W. Cooke.

Journal of Geology for November-December: "Diastrophism as the Ultimate Basis of Correlation," Thomas C. Chamberlin; "Concerning Certain Criteria for Discrimination of the Age of Glacial Drift Sheets as Modified by Topographic Situation and Drainage Relations," William C. Alden; "The Bearing of the Stratigraphic History and Invertebrate Fossils on the Age of the Anthracolithic Rocks of Kansas and Oklahoma," J. W. Beede; "Petrology of the South Carolina Granites," Thomas L. Watson.

Mining Science for December 16: "The Marine Organic Origin of Petroleum," Arthur Lakes; for December 23: "The Science of Management Engineering," Halbert P. Gillett; for December 30: Brazil's Immense Iron-Ore Deposits.

Mount Weather Observatory, Bulletin of the, December: "Certain Laws of Radiation and Absorption and a Few of Their Applications," W. J. Humphreys; "An Unusual Display of False Cirrus," W. J. Humphreys; "The Aërological Congress at Monaco," A. L. Rotch.

Plant World, The for December: "Successional Relations of the Vegetation about Yarmouth, Nova Scotia," E. N. Transeau; "The Reciprocal Influence of Scion Stock," W. B. McCallum; "Vegetation Groups of the Desert Laboratory Domain," J. J. Thomber.

School Review for January: "The Commercial High School and the Business Community," F. V. Thompson; "High-School Mathematics," Thirmuthis Brookman; "University Extension in Tennessee High Schools," Josiah Main.

Technical World Magazine for January: "On the Trail of the Tiger," the City Fuel Company—George H. Cushing; "Pulling the River's Teeth," Harris Dickson; "Heroism versus Insurance," R. W. Emerson; "A School for Railroad Managers," S. O. Dunn; "Pellagrins—Newest Disease Victims," Frederic Blount Warren; "Wonders of Alaskan Agriculture," Guy Elliott Mitchell; "Fire Writes a Heart's Record," H. G. Hunting; "Some Roosevelt Hunting Trophies," Frank N. Bauskett.

Zeitschrift für den Physikalischen und Chemischen Unterricht for November: Ruoss, "Unrichtigkeiten aus dem Gebiet der Elektrostatik;" V. Erlemann, "Demonstrations-Schieber-und Stöpselrheostat;" P. Bräuer, "Uber einen neuen Apparat zur Darstellung flüssiger Luft;" W. Biegon von Czudnochowski, "Demonstrations-versuche über elektrische Kraftlinien mit Hilfe von 'elektrischen Papierbüscheln'"; E. Schulze, "Noch einmal der Kräfteparallelogramm-Versuch." KLEINE MITTEILUNGEN. Cölestin Krupka, "Apparat zum Nachweise der Spannkraft von vergasten Flüssigkeiten in der Torricellischen Leere"; S. Henrichsen, "Uber die Polorisation durch Reflexion"; H. Schüepp, Zur Demonstration des Regenbogens"; P. Weinmeister, "Die 'Achse' des sphärischen Hohlspiegels"; O. Ohmann, "Kleinere chemische Unterrichtsversuche und Notizen."

MATHEMATICS SECTION OF THE ASSOCIATION OF KENIUCKY COLLEGES.

The Mathematics Section of the Association of Kentucky Colleges held a meeting at Lexington on Dec. 4.

The feature of the session was the discussion of a course of study for the high schools of the state. The following was unanimously agreed upon: simple elementary algebra, for at least half a year, should precede the high school course; the first year in high school should cover algebra to quadratics with a brief study of quadratics; geometry, plane completed, should occupy the second year, and free use should be made of algebra; the third year should be given to the completion of high school algebra, with much use of geometry as the source of problems.

The section will meet at Georgetown in April, and until that time will devote itself to working out the correlation of the different branches of high and elementary school mathematics, and may have something of considerable interest to report later.

The question of the best use of a fourth year in mathematics in high schools is still under consideration. JOSEPHINE A. ROBINSON.

ASSOCIATION OF THE TEACHERS OF MATHEMATICS IN THE MIDDLE STATES AND MARYLAND.

The thirteenth meeting of this Association was held at the College of the City of New York on Saturday, December 4. The day was given up to the reading of two papers—"Mathematics in the Ethical Culture High School," by Charles B. Walsh of New York City, and "Some Suggestions in the Teaching of Geometry," by Isaac J. Schwatt of the University of Pennsylvania, and to the reports of the various committees. The most important report was the one on Algebra Syllabus, presented by the chairman, Gustave Legras, College of the City of New York.

The Algebra Syllabus was discussed in detail, and, after some amendments, was adopted by the Association. The committee was continued, with power to make any necessary alterations in the preliminary report and to make out the syllabus for advanced algebra.

The following officers were elected for the year: President, William H. Metzler, Syracuse University; vice-president, Daniel D. Feldman, Erasmus Hall High School, Brooklyn; secretary, Eugene R. Smith, Polytechnic Preparatory School, Brooklyn; treasurer, M. Edna Shaw, William Penn High School, Philadelphia; members of the council (2 years), Paul N. Beck, George Washington University, Washington, D. C.; (3 years), Howard F. Hart, High School, Montclair, N. J.; Isaac J. Schwatt, University of Pennsylvania.

The secretary was instructed to report for the Association at the Federation meeting in Boston, December 27.

EUGENE R. SMITH, Secretary.

EASTERN ASSOCIATION OF PHYSICS TEACHERS.

The fifty-fourth meeting of the Eastern Association of Physics Teachers was held in Boston, November 19 and 20. The meeting began with a dinner at the Boston City Club, Friday evening. An after-dinner discussion on "Some Impressions in Regard to German Schools" was held, indulged in by Messrs. J. C. Packard, Lyman G. Smith, and Frederick G. Jackson. Each of these men had recently been in Germany. Mr. Jackson in his talk dealt very largely on the great amount of time that the German pupils are obliged to devote to their work. He stated that the German teachers have no athletic problems to solve, as inter-school contests of this nature do not find favor over there. Mr. Smith spoke mainly upon the course of study in operation in Germany, sighting samples of questions the pupil is obliged to pass in order to gain admission to the university as well as giving him certain advantages such as employment in the public service.

Mr. Packard confined his remark chiefly to the laboratory work in German schools. He brought out the fact that much more time is spent on the subject there than we are giving to it even under the impetus of the "New Movement." He said, "*We cannot compete, successfully, with our physics coming but five times a week for one year.*"

The Saturday morning session was held in the Jefferson Physical Laboratory of Harvard University. The first item of business was the election of new members, followed by the report of the committee on new apparatus; several new pieces were shown. The committees on Magazine Literature, Current Events in Physics, and Foreign Relations presented their reports. Professor Frank M. Greenlaw gave a very interesting illustrated address on "Something About Wireless." Professor W. F. Magie of Princeton University gave his lecture on "The Historic Method of Teaching Physics." C. H. S.

IOWA ASSOCIATION OF SCIENCE TEACHERS.

The section meetings were held on Thursday afternoon, November 4, 1909, in the lecture rooms of the West Des Moines High School. The attendance was the largest in the history of the Association.

The chemistry and physics sections met together. The former was called to order by the leader, Sara M. Nollen of West High School. S. L. Thomas of Council Bluffs was chosen section leader for the coming year. The committee on correlation of high school and college chemistry was not ready to report and was continued another year. The members of the committee are Prof. A. A. Bennett, Iowa State College, chairman; Prof. W. S. Hendrixson, Iowa College; Geo. W. Tidd, Ft. Dodge; L. Higgins, West Des Moines High School; Emma J. Fordyce, Cedar Rapids.

The program consisted of an informal discussion of the following topics: 1. What shall be the nature of the work in qualitative analysis and how much time shall be given to it? The discussion, led by Mr.

Tidd of Ft. Dodge, developed the fact that a number were devoting three or four weeks at the end of the course to elementary qualitative analysis, while others undertook no formal analysis of any sort but at the close of the study of each group in the general course gave a few unknowns including the elements and groups already studied.

2. How much theory should be taught and when? The discussion was led by Miss Wilson of Marshalltown and brought out considerable difference of opinion. Some held that theory should be given very early, others that it should not be introduced till after the facts supporting the theories have been studied.

The physics section was called to order by Prof. Begeman of Cedar Falls. Prof. Morehouse of Drake University led in the discussion of the topic: "Fundamental Concepts in Electricity for the Secondary School." This was followed by the discussion of "Fundamental Concepts in Mechanics," led by Prof. Titsworth of Des Moines College. The latter discussion brought out the fact that the sentiment of a majority of those present was against the elimination of kinetics and absolute units from the high school course.

An interesting and spirited discussion was aroused on the cultural course in the high school. This was led by Mr. Geo. W. Tidd of Ft. Dodge who advocated two courses in the larger high schools, alternating if necessary in successive years and only the cultural course in smaller schools with inadequate equipment and teaching force. The sentiment was about evenly divided on the latter plan. Prof. D. W. Morehouse of Drake University was chosen leader of the section for next year.

The biology and physiography sections met together with about a hundred in attendance. The Biology section was called to order by Miss Lena A. Barber of Sioux City. After election of Prof. R. B. Wylie as section leader for next year, the following program was carried out:

Miss Etta Bardwell of Cedar Rapids read a paper on the Biology Notebook in which she emphasized the importance of accuracy in sketches and description and of cultivating independence and self-reliance on the part of the pupil. The Cultural Value of Bird Study was the topic of an interesting paper by Miss Katherine Macy of Grinnell. Miss Macy spoke largely out of her own experience in bird study with her own classes and of its value in training the child in habits of alert attention to the whole world about him.

Prof. R. B. Wylie of Iowa City presented the results of an investigation into the extent and nature of the work in botany in Iowa high schools. He found that about 90% of the schools offer one semester of botany, 52% offering it in the first year and 36% in the second. 10% schedule it in the third year, and 2% in the fourth. The nature of the work as it is and as it should be was also discussed at length.

The General Session.

The general session of the Association was held Friday afternoon with Pres. John L. Tilton of Simpson College in the chair.

The program was as follows:

I. "How can science teachers who are well equipped be given the preference in selecting teachers?" Prof. D. W. Morehouse, Drake University.

II. "Summer Courses for Science Teachers," Frances McFarland, West Des Moines High School.

III. Reference Books and Important Magazine Articles.

1. In Chemistry, Sara M. Nollen.
2. In Physics, Prof. L. Begeman.
3. In Biology, Lena Barber.
4. In Physiography, Prof. W. H. Norton.

IV. Address: "The Teaching of Physiography," Prof. R. D. Salisbury. University of Chicago.

The nominating committee reported the following for officers and the report was adopted: Geo. W. Tidd, Ft. Dodge, president; Prof. L. Begeman, Cedar Falls, vice-president; F. E. Goodell, Des Moines, sec.-treas.

F. E. GOODELL, Secretary.

REPORT OF MEETING OF THE EARTH SCIENCE SECTION OF THE C. A. OF S. AND M. T.

The Earth Science Section of the Central Association of Sciences and Mathematics Teachers met in Room 14 of Kent Chemical Laboratory of The University of Chicago, on Friday afternoon and Saturday morning, November 26 and 27. The attendance was about fifty at each meeting. Miss Marion Weller, the chairman, presided.

The chair appointed as a nominating committee Mr. Charles E. Peet, Mr. W. E. Durstine, and Dr. W. S. Grant, and as a committee on resolutions, Mr. H. M. Clem and Miss H. M. Collins.

Professor Richard E. Dodge of Teachers' College, Columbia University, led the discussion Friday afternoon on the topic, "Geography in the Secondary School." The discussion was participated in by a number of members present. A syllabus of Professor Dodge's paper follows:

1. Present Character of Secondary School Geography.
   Largely physical geography with or without laboratory work; some commercial geography causally taught; some commercial geography taught in an informational way.
2. Modern Physical Geography.
   (*a*) Generally includes Earth in Space, Atmosphere, Lands, Oceans, and some treatment of isolated life responses or of distribution of larger life conditions.
   (*b*) In better secondary and normal schools includes much laboratory work on Earth in Space, Lands and Atmosphere. Much of this is forced in character and a good deal of it not geographic in nature.
   (*c*) Two Groups of Courses.
      1. Systematic, following outline like College Entrance Examination Board Requirement and most texts.
      2. Informational, including a large number of facts and prin-

ciples unrelated to systematic development of subject.

3. Advantages and Disadvantages of Present Course.
4. Needs of Pupils in Secondary Schools in Reference to Geography.
5. Content of Most Value in High School Work.
   (*a*) Should deal largely with regions—say, United States and Western Europe.
   (*b*) Regional study of high school should be more advanced and more scientific than any work possible in elementary schools.
   (*c*) Work should begin with study of those phases of physical geography which are necessary as a basis for systematic, causal, regional geography. Physical geography is not therefore an end in itself but a means to an end.
   (*d*) Work should find its application and use in scientific, causal study of political and commercial geography, in geography of life, in a large way.
   (*e*) Such a course would be a compound of selected phases of present physical geography and of principles of commercial geography, with special study of selected regions as wholes.
   (*f*) Should be so taught that any pupils can study any other region alone in similar scientific way.
   (*g*) Advantages gained from laboratory study of present physical geography should not in any way be sacrificed.
   (*h*) Such a course would best, perhaps, be divided into parts: (1) physical geography in which only those phases of the subject should be included which later will be needed and those studied so as to suggest their application, and (2) regional geography in which given regions are studied systematically from larger topics of position, climate, surface, etc., to a climax in economic and social phases.
6. Possibility of Such a Course.
7. General Conclusion.

   Such a combined course, or one on similar lines, would retain all the advantages gained from the modern study of physical geography, would avoid many of the difficulties, would be more generally adapted to pupils' needs, would be equally adapted to college entrance requirements from standpoint of training secured, would give a better foundation for work in college or for general study in related fields, would allow for causal study of commercial conditions, and relations, would appeal to the public, and can at once be undertaken by trained teachers.

At the Saturday morning meeting, Mr. C. E. Peet presented the report of the nominating committee as follows: W. M. Gregory, chairman, Cleveland Normal School, Cleveland; K. C. Fitch, vice-chairman, Englewood High School, Chicago; G. R. Mansfield, secretary, Northwestern University. The report was accepted and adopted, and the nominees unanimously elected.

Mr. W. M. Gregory read an admirable paper on "Geography in the Secondary Schools of the Middle West." The paper was discussed by Mr. C. E. Peet, who advocated careful experimentation by secondary

school teachers to determine what phases of geography can be most effectively taught in the high school, paying attention to the obvious interests of the students as well as a logical development of subject matter.

Mr. R. H. Whitbeck read a valuable paper on "The Present Trend in Geography." He demonstrated a marked movement over the country toward introducing much geography into courses of physiography, and, in many places, of organizing new courses in which the emphasis is placed on geography, but in which constant reference is made to pertinent physiographical and geological conditions as controlling factors.

Miss Bertha Henderson read an interesting paper discussing Mr. Whitbeck's paper and demonstrated the advisability in a normal school, at least, of teaching physiographic principles as affecting the environment of man, rather than working out an analysis of physiographic activities and conditions.

Mr. Clem of the committee on resolutions presented the following for adoption:

"Resolved, that the Earth Science section of the Central Association of Science and Mathematics Teachers express its sympathetic attitude toward the course of study in secondary school geography outlined and recommended by Professor R. E. Dodge to the effect that the course be modified so as to include a larger amount of human geography, that the final goal should be regional geography in some form, that this regional geography should be based on a thorough study of the essential elements of physiography, and should include the most important principles and details of industrial and commercial geography."

The resolution was adopted.

The committee further recommended the following resolution, which was adopted:

"Resolved, that the Earth Science Section of the Central Association of the Science and Mathematics Teachers tender its thanks to Prof. R. E. Dodge, who has so efficiently led the round table discussion on the course in secondary school geography, and has so effectively succeeded in defining the purpose and scope of such a course; and to Professors Gregory, Peet, Whitbeck, and Henderson, and others, who have made many useful and inspiring suggestions in behalf of the definition and improvement of geography."

Mr. James H. Smith moved that the chair appoint from this section a member of the general committee on standardization, and, after the motion was carried, the chair appointed Mr. Charles H. Treadwell.

Mr. Smith moved further that the chair appoint a committee of five to make a scientific study of the teaching of physiography, by comparing the results of teaching the same topic in different ways. The motion was carried, and the chair appointed Mrs. J. P. Cook, chairman, Mr. W. E. Durstine, Mr. S. Hayes, Miss G. Ellis, and Miss B. Henderson.

HARRY O. GILLET, Secretary.

INTERNATIONAL CONFERENCE ON A MAP OF THE WORLD

Plan for Coöperative Mapping.

At the Fifth International Geographical Congress, held at Bern in 1891, Prof. Albrecht Penck, a well-known geographer, proposed that the enlightened nations that were engaged in making maps of their own territory and of other countries should unite upon a common plan for the preparation of a general map of the world. He suggested that the scale of the map should be 1:1,000,000, or about 16 miles to the inch, and that the separate sheets of the map should be so bounded by meridians and parallels that any two sheets representing adjacent areas should match, except for distortion of projection, no matter by what country either sheet might be made. This proposal led to resolutions and discussions at subsequent geographic congresses and to the preparation of several tentative maps by Germany, France, England, and the United States, in conformity with the general plan proposed by Professor Penck.

A Meeting in London.

At the Ninth International Geographic Congress, held at Geneva in July, 1908, a resolution was presented by Henry Gannett, of the United States Geological Survey, providing for the formation of an international committee to which should be intrusted the arrangement of details for a closer and more definite coöperation in the preparation of the proposed world map. That resolution was adopted and in conformity with its terms and with the recommendations of a committee appointed at Geneva the British Government has recently invited Austria-Hungary, France, Germany, Italy, Japan, Russia, Spain, and the United States to send their representatives to a meeting to be held in London on November 16, 1909, to provide for the standardization of an international map on the scale of 1:1,000,000. The British delegates will consist of representatives of Great Britain, Canada, Australia, and India. At this conference the various details that are essential to the preparation of a uniform map will be discussed and it is hoped that an agreement may be reached.

United States to be Represented.

The United States Geological Survey has for some time past been engaged in compiling maps of portions of the United States on the scale of 1:1,000,000 in accordance with a plan which embodies the principal features on which agreement with other nations is expected. In view of the Geological Survey's interest in the results of this conference, Bailey Willis, geologist, and S. J. Kübel, chief engraver, of the Survey, have been sent to London as representatives of the United States.—*U. S. Geol. Survey.*

CADMIUM.

The chief source of cadmium is zinc ore, though small quantities of this comparatively rare metal are contained in some lead ores. The world's cadmium output is derived largely from Silesia, but within the last two years the metal has been produced in the United States, and the value of the annual imports of cadmium has dropped during that time from $10,500 to $2,300. The zinc ore of the Joplin district contains as high a percentage of the metal as the cadmium-bearing zinc ores of Silesia.

Some Uses of Cadmium.

Cadmium melts at a low temperature and, like bismuth, lowers the melting point of alloys in which it is used. Bismuth, however, forms brittle alloys, but many alloys of cadmium are ductile and malleable, yet hard. The melting points of these alloys are lower than the melting points of any of the metals composing them. Several of them liquefy at temperatures considerably below that of boiling water. An alloy of cadmium is used in making automatic fire extinguishers, in which water under pressure is released in a jet or spray by the melting of cadmium under the heat of the fire.

The brilliant yellow pigment known as cadmium yellow is cadmium sulphide, which forms one of the most permanent colors obtainable for artists. This pigment is used also by some railway and street-car companies as a protective covering for other less permanent yellows that are employed in painting their cars and coaches. Yellow paints that are darkened by the sulphide gases in coal smoke or that fade under the action of sunlight are in this way kept brilliant by a semitransparent coat of cadmium yellow.—*U. S. Geol. Survey.*

The hookworm disease does not exist north of the Potomac. The American worm must thrive in a certain temperature. It feeds only on the human intestines and is widely prevalent in the South. It enters the system to some extent through the mouth, but for the most part through the skin. It passes through the lungs into the stomach and lodges in the intestines, where it feeds on the mucous membrane, forming a poison which, while rarely fatal, renders the victim anæmic, retards development, and by lowering his vitality makes him easily subject to typhoid, pneumonia, and other more serious diseases.

CHANGES IN THE MONTHLY WEATHER REVIEW.

In the issues of the Monthly Weather Review for February and March, 1909, we published in full all the pertinent parts of orders issued by the Chief of the U. S. Weather Bureau, outlining changes which he planned to make in the character of the *Review*, beginning with the issue for July, 1909. At the beginning of the announcement in the issue for February the following statement was made:

> It appears from the following that those readers particularly interested in *climatological statistics* should request that the REVIEW be continued to their addresses; those who are more interested in theoretical and technical discussions of data should request that the Mount Weather Bulletin be sent them in place of the MONTHLY WEATHER REVIEW.

It appears that there are many who have not read these notices and outlines of prospective changes, and the Weather Bureau is still frequently requested to renew or add to its subscription list recipients who apparently do not realize the character of the new publications.

Our readers are therefore informed that beginning with the issue for July, 1909, the MONTHLY WEATHER REVIEW will be restricted to statistical tables of general climatological data for the whole of the United States. The relatively small amount of accompanying text will summarize the weather conditions of the month in the different districts. It is thus evident that hereafter the REVIEW will be of value only to those advanced students of climates, engineers, etc., who need detailed data for their own discussion.

Few papers of general interest to teachers, except as related to climatology, will be published in the MONTHLY WEATHER REVIEW, and it is not probable that the publication will be of value to those public schools and high schools that have been receiving it heretofore. These circles of readers must now turn to the editors of already existing journals to supply their needs along those lines formerly met, perhaps, by articles in the MONTHLY WEATHER REVIEW.

We may here also take the opportunity to remark that the scope of the articles appearing in the Mount Weather Bulletin will be limited to technical treatments of subjects of advanced research. This will make most of the articles of that publication also beyond the comprehension of the average pupil of the above grades of schools, and make the Bulletin only appropriate for the libraries of colleges and universities.—*C. A. Reprinted from the Monthly Weather Review, May, 1909.*

The boundaries between the sciences are arbitrary, and tend to disappear as science progresses. The principles of one science often find most striking and suggestive illustrations in the phenomena of another. Thus, for example, the physicist finds in astronomy that effects he has observed in the laboratory are illustrated on the grand scale in the sun and stars. No better illustration of this could be given than Prof. Hale's recent discovery of the Zeeman effect in the light from sun spots; in chemistry, too, the physicist finds in the behavior of whole series of reactions illustrations of the great laws of thermodynamics, while if he turns to the biological sciences he is confronted by problems, mostly unsolved, of unsurpassed interest.

BOOKS RECEIVED.

The Calculus and Its Applications. A practical treatise for beginners, especially engineering students, by Robert Gordon Blaine, M. E., lecturer at the City Guilds Technical College, Finsbury, London. Pages ix+321. Price, $1.50 net. D. Van Nostrand Company, New York.

Proceedings of the Forty-seventh Annual Convocation of the University of the State of New York.

The Manual Arts for Elementary Schools, Drawing, Design, Construction. D. C. Heath and Company, Boston.

Rum and Ruin. The Story of Dr. Caldwell. A thrilling romance, by Edward R. Roe. Pp. 251. 1909. Laird & Lee, Chicago. Cloth, $1.00; paper covers, 25c.

Laird & Lee's Standard Vest-Pocket English-Italian, Italian-English Dictionary. Pp. 528. 1909. Laird & Lee, Chicago. Price, leather, 75c; cloth, 50c.

The New Salesmanship and How to Do Business by Mail, by Chas. Lindgren. Pp. 190. 1909. Laird & Lee, Chicago. Extra cloth, $1.50.

Manual of Physical Geography, by F. V. Emerson. Pp. 291. 1909. The Macmillan Company. Price, $1.40 net.

BOOK REVIEWS.

Human Physiology, an elementary text-book of anatomy, physiology, and hygiene. By John W. Ritchie, Professor of Biology, College of William and Mary, Virginia. New World Science Series. World Book Company, Yonkers-on-Hudson, New York, 1909. 362 pages, 157 figures. Price, 96c.

Very many elementary human physiologies have been written; a new one should, therefore, have a valid excuse for its appearance. At first sight the present book is disappointing, as it makes little use of experimental work. The book is simply a reading book. I find three things for which to commend it. First, the author has succeeded in telling his story in a simple, clear, straight-forward style that is in pleasing contrast to the majority of science books written for young people. The paragraphing and use of leaded and italicized types are also good. The second good feature is the extended section devoted to germ diseases, about sixty pages, with a special chapter on tuberculosis. This is undoubtedly the most valuable feature of the book. The germs, both bacteria and protozoa, are clearly described as they appear in the most important diseases, together with methods of prevention, toxins, antitoxins, vaccination, use of disinfectants, etc. A third feature not often seen in books of this sort is the comparison of the organs of man with those of other animals. This comparison is brief, of course, but will probably lend interest to the study.

The author is always very positive in his statements. This, of course, for young readers, adds clearness, but when the facts are unknown or in doubt it would be better to qualify the statements. A case in point is the view taken of oxidation within the cells, likening it in the

usual way to the burning of wood and coal. Many of the best workers now take quite a different view of what goes on in the cell in respiration. Statements intended for young people should be scrupulously accurate, and in the case of unsettled theories the situation should be frankly stated. It is, too often, necessary for the student, as he advances, to unlearn many things—always a slow and painful process. In the opinion of the reviewer elementary text-books of human physiology should contain a minimum of anatomy and a maximum of hygiene and physiology—just enough anatomy to make the others clear. The book under review is to be commended for the step it has taken in this direction.

W. W.

The History of the Teaching of Elementary Geometry, with Reference to Present-day Problems, by Alva W. Stamper, Ph.D., State Normal School, Chico, Cal. Pp. x+163. $1.50. 1909. Columbia University, Contributions to Education, Teachers College.

There are a few books which to the teacher of secondary mathematics are a never failing source of information and helpful suggestions for immediate use in the class room. To the Teaching of Mathematics, by Dr. J. W. A. Young, and A Short Account of the History of Mathematics by W. W. R. Ball (or History of Elementary Mathematics by Professor F. Cajori), to mention only two or three, may be added this History of the Teaching of Elementary Geometry by Dr. Stamper. The teacher who is well acquainted with these books has a basis of knowledge for high efficiency in attempting to make the work in mathematics fit closer to the needs of the average high school pupil.

The first three chapters are drawn for the most part from the standard histories of mathematics; but the material for the next three chapters has been obtained very largely from the original sources. In Chapter I, The Teaching of Geometry before Euclid, is an account of the beginning of geometry among primitive people, the geometry of the Egyptians and of the Greeks. Chapter II, The Work of Euclid and His Influence on the subsequent Teaching of Geometry, gives a brief summary of the main contributions to Euclid, and the later influence of Euclid. In Chapter III, The Teaching of Geometry from Euclid to the Rise of the Christian Schools, geometry at Alexandria, and among the Hindus, Arabs, and Romans is considered. Chapter IV, The Teaching of Geometry from the Rise of the Christian Schools to the Year 1525, treats of the Christian schools and the universities of the middle ages. Chapter V, The Teaching of Geometry from the Year 1525 to the present Time, is an account of some early printed books on geometry, and the teaching of geometry in Germany, France, England, Russia, Holland, and the United States. Chapter VI, Present-day Teaching of Geometry, gives in some detail the class room methods and movements for reform in the various countries. In Chapter VII, Present Problems and their Historic Connections, there is a historic survey, and an excellent discussion of the present-day problems in the teaching of geometry.

This book should be in every high school library and on the desk of every teacher of geometry. It gives a perspective which aids greatly

In the attempt to solve the problem of teaching a school subject as a preparation of many pupils for effective service rather than of a few pupils for higher studies. H. E. C.

Elements of Agriculture, by G. F. Warren. Pp. 434+24. Macmillan Company, New York.

"In preparing this book, the author has tried to carry out, as far as possible, the recommendations of the committee on methods of teaching agriculture of the Association of American Agricultural Colleges and Experiments Stations."

There are eighteen chapters in which all of the various subjects usually included under the name agriculture are well treated. The text of each chapter is followed by a list of questions, laboratory exercises, and a list of references for collateral reading.

The following summary of chapter II dealing with plant and animal improvement will give some idea of the completeness which characterizes the treatment of the various subjects throughout the book: Improvement of plants and animals, including as subtopics: variation in plants and animals, laws of variation, similar produces similar, natural selection, sports or mutations (the author regarding these as synonymous), development of weeds by natural selection, De Comdolle's law, artificial selection. Reproduction in plants, including as subtopics: seed producing organs of plants, sexual and asexual reproduction, artificial crossing. Some principles of heredity, including as subtopics: problems of heredity, Mendel's law (four-page discussion in which an abstract of Mendel's own experiments and results is given), application of Mendel's law. Steps in breeding, including as subtopics: variation, selection, testing hereditary power. Improving some farm crops, including as subtopics: plant-breeding vs. animal breeding, comparative improvement of different crops, sugar-beet, corn improvement, cotton, other cross-fertilized plants, oats, other self-fertilized plants, potatoes, how often do potatoes need to be grown from seed-ball, plant-breeding farms.

If questions are desirable in a text-book the ones given by the author are of the right kind. They call for interpretation of the text instead of mere reproduction. This chapter is reviewed by means of thirteen questions. "Why is the ratio in which hybrids break up not exactly 3 to 1 when dealing with small numbers?" is a fair sample.

The laboratory exercises deal concretely with all points in the text capable of laboratory treatment. Under collateral reading (chap. II) fourteen references are given.

Some very useful tables are brought together in the appendix, including apparatus and equipment, library, list of agricultural colleges and experiment stations, seeds, weights, fertilizers, feeding standards, nutrients, value of feeding stuffs, and statistics of agricultural products.

On the whole the book is a well-balanced, carefully written, up-to-date presentation of the subject. Besides, it is the first text-book on agriculture for secondary schools that has appeared. B. M. D.

The Nature-Study Idea, by L. H. Bailey; third edition, revised; pages ix+246; published by the Macmillan Company, New York. Price, $1.25 net. 1909.

"The Nature-Study Idea," which was first issued several years ago, has just been reissued in an enlarged and more extensive form. The general plan is the same of the former book, but many changes have been made, changes that bring the book into harmony with those things in the teaching of nature-study that have been happening since 1903, when the first book was written. Since the date mentioned nature-study has secured a rather firm hold in many schools, and indeed it may not now be said to be a question as to whether the subject will be taught in the schools, but just what shall be taught and how shall it be taught. The subject is pretty well recognized as one that has come to stay. Also since the date of the writing of the former book, the school garden as a laboratory for the nature-study work has become pretty well introduced and this subject is given more and better recognition than in the former book. The school garden has been the means of giving definiteness and that practicable aspect to nature-study that has made it have meaning where it formerly seemed more or less purposeless. The school garden has also given the proper kind of relation between the nature-study in general and that part of it that relates to elementary agriculture.

As is usual in Professor Bailey's writing he constantly urges against formality in teaching, a contention that appeals to all of us, but which is extremely difficult to put into practice when the teacher has fifty pupils and a list of subjects so long that even with very definite planning beforehand she cannot do all of these subjects justice. It is necessary to have definite plans for the nature-study work as for other things if success is to be had. There has been much well-earned abuse for nature-study simply because it was not well planned. It is not to be inferred that Mr. Bailey argues against well-planned work, indeed I am sure he believes in it. But with the emphasis properly upon absence of formality, and disclaiming distinctly any attempt to help the teacher by giving definite things that she may do, the result upon some teachers will doubtless be an impression that there is a virtue in not having a definite plan for the work that is to be undertaken. This inference is the one thing of all others that has given the subject its present ill-repute in some places. Mr. Bailey says: "I have not cared to prepare an outline for class work; the book is concerned with the nature-study idea." That the book even without this desired definiteness has stimulated and will continue to stimulate people and to open the way for the subject in the schools, all must recognize that the things the teachers want just now, however, is specific assistance on some of the pieces of work that they can undertake. "What can we do?" not "Can you convince us that we should do something?" is the question that is most often presented. As a general statement of the purposes of nature-study, its spirit and its scope, the book is most excellent. O. W. C.

It is expected that several new officers of instruction will be added to the Department of Mathematics of Columbia University at the close of the present academic year.